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EDITORIAL NOTES

Native Land Tenure.

The article by Mr. Liversage in this issue of the *Journal* should command attention from a wider circle than is supplied by readers interested in agriculture. In relation to native administration there is no other subject, even indirect rule or soil erosion, which approaches it in fundamental importance. Broadly speaking we found the African with a social system which, however primitive and whatever its defects and limitations, ensures access for all to the land by which all must live, on the simple principle of limiting individual possession to the extent and to the period of effective use. The system provides scope for the production of food crops in proportion to the industry of the individual concerned and the number of his working family. In the case of an orange tree or a coconut palm property is held in the tree itself and not the land on which it grows. The freedom of movement allowed within the common area permits the practice of shifting cultivation, involving the restoration of land by bush fallow, to be carried out with a minimum of difficulty. The system produces an untidy country-side, and is inefficient for any but its primary purpose, but at its best, where land is sufficient in proportion to population to allow of adequate periods of recuperation, it provides a permanent basis for a stable social order.

Various factors are now disturbing the balance of this Arcadian simplicity. To the production of such annual cash crops as cotton no limit is set by the means for their disposal, and the area under cultivation is extended as far as the force of attraction of money and the pressure of

agencies interested in increasing production can exert their influence.

The effect of this extension, and of the permanent occupation of land by such crops as coffee is to throw an ever-increasing strain on the land left available for food production, upsetting the cycle of use and recovery on which primitive agriculture and the primitive social order together depend.

The obvious agricultural remedy is more intensive cultivation, involving the use of manure, but this cannot be accomplished without some form of fixed tenure. The position may be compared with that of English villages at the time of the Enclosure Acts. Much of the future well-being of the African native depends on whether during the period of inevitable transition a wise guidance is applied or matters are just allowed to drift.

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MIXED FARMING IN EAST AFRICA.

The days of land exploitation and one-crop farming are passing in East Africa. The cereal farmer is becoming aware of the necessity to produce farmyard (*boma*) manure or compost in order to keep up his grain yields to a profitable level; he is coming to appreciate, too, the potential value of utilizing some of his grain, especially the inferior grades, in the production of live stock or butterfat rather than throwing the grain on to a reluctant, and perhaps falling, market. The dairy herd enables the general farmer to employ some rotation of crops and of pasturage which will enable fertility to be banked in the soil and to be cashed profitably by a cereal crop later on; an additional advantage is that soil erosion is never so serious on mixed farms as on farms where only crops are raised. The rotation will assist also in checking the spread and reducing the severity of the incidence of the many parasitic or semi-parasitic diseases to which the cereals are subject. The coffee farmer, also, especially in those areas where the coffee plantation is not the only interest on the farm and where ample land is available, is beginning to see the value of increasing the fertility of his coffee plantation by means of stock.

While East Africa offers many advantages to the dairy farmer in the way of cheap food-stuffs, ample rainfall in the main arable farming areas, and a cheap labour supply, there are many difficulties to be overcome and the drawbacks of high transport costs and, often, low world prices for animal produce must be countered by the employment of an efficient technique of production.

Dairying has been carried out for many years with varying degrees of success by farmers in the so-called "pastoral areas" of the Colony; a higher scale of production and more intensive methods must replace in many areas the semi-ranching system which has been employed by farmers, since a good living normally necessitates a sufficiently high output from the individual farm. The farmers in the arable districts often have had no previous experience with dairy animals or pigs and knowledge gained by methods of trial and error is apt to be gained tardily and at a bitter cost; even if a farmer is used to dairying and stock rearing in other parts of the world, he may find it difficult to adjust his ideas to the new conditions, unsupported as he is by the wealth of local tradition which aids a new farmer in the older-established farming countries.

With these considerations in mind it has been decided to publish a series of articles in the *East African Agricultural Journal* which will deal with various aspects of mixed farming in East Africa.

The articles will be based on knowledge gained by officers of the Agricultural Departments of the East African territories as a result of experiment and observation and on suggestions made by practical farmers. It is intended in this brief note not to do more than introduce this series of articles and not to deal at length with the pros and cons of mixed farming. It is hoped, however, that these articles, the first of which appears in this number of the *Journal*, will prove a help to farmers in East Africa who are attempting to broaden the basis of their operations by the inclusion of stock.

Readers of these articles in Kenya may find it useful to refer to the article in the last number of the *Journal* entitled "Report on Grassland Improvement in Kenya", by D. C. Edwards, of the Kenya Department of Agriculture.

In conclusion it must be observed that, since dairy farming and other branches of mixed farming are still in their infancy in East Africa, and certain matters touched upon may be to some extent controversial, the opinions expressed in the articles must be considered as those of the writers.

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PASSION FRUIT OR GRANADILLA JUICE.

The juice of *Passiflora edulis*, the passion fruit or purple granadilla, is finding an increasing use in Europe and America in cordials, cocktails and flavouring for ice-cream.

Samples of the juice were prepared at Kitale by the Kenya Department of Agriculture in 1933 and sent home to London for commercial report. These samples were very favourably reported upon by merchants who are interested in the product and were found by several authorities to be of markedly superior flavour and strength to the commercial passion fruit juice which is imported from New Zealand.

At the end of 1933 it was stated by a business man interested in passion fruit juice that there should be a permanent market for the juice in London at about Sh. 6 per gallon.

Subsequently the handling of the commercial side of this potential new Kenya industry was taken over by the Kenya Farmers' Association who sent two barrels of the juice to London in June, 1935. A report was received to the effect that the quality submitted should be marketable at about Sh. 4 to Sh. 5 per gallon, duty free, ex wharf, London terms and conditions, as against a price of Sh. 1/6 or Sh. 2/6 per gallon for lemon, orange or grape fruit juices.

A well-known Kenya farmer, who has a plantation of several acres of passion fruit in the Trans Nzoia, is preparing and marketing a cordial which is becoming very popular in the Kenya clubs. When diluted with four parts of water the cordial makes a very palatable and inexpensive drink.

Articles on the cultivation of *Passiflora edulis* and on the preparation of the juice will be found elsewhere in this issue. It is hoped that the production of granadilla juice in Kenya will develop into a not inconsiderable industry in the Colony.

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LUCERNE SPECIES AND TEFF GRASS (*Eragrostis Abyssinica*).

The following is an extract from a letter received by Dr. Whyte of the Imperial Bureau of Plant Genetics: Herbage Plants, Aberystwyth, from Dr. A. I. Belov, Central Plant Breeding Station of Stredaz, N.I.H.I., Tashkent, U.S.S.R., with reference to an inquiry from Kenya regarding the use of lucerne in mixtures with teff grass:—

" . . . Regarding the suggested mixture of teff with annual lucernes I can make the following remarks: Vigorously growing varieties of *M. Sativa* such as lucernes from Sudan, Southern India and other tropical countries should be suitable for mixing with teff. Such lucernes should be cultivated as annual crops. Seeds of these lucernes are more readily available than those of *M. orbicularis* or *M. arabica.* Moreover, the Sudan and Southern Indian lucernes are more similar to teff in their development than *M. orbicularis* and *arabica.* Experimental sowings of these lucernes from Sudan and Southern India, etc., made in Central Asia for use for one year as hay (and not as pasture) showed the advisability of sowing such a mixture. At the present time we are reproducing seeds of these lucernes and of teff for large field experiments on farms. This type of sowing is very promising for use in an intensive crop rotation with cotton. The cotton crop following these lucernes gives a fairly large increase in yield. Thus, for instance, in our experiments cotton following these lucernes gave an increase in yield of 50-70 per cent, while the Central Agrotechnical Station in Stredaz, N.I.H.I., reported an increase of from 65-80 per cent after the same lucernes . . . "

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SPRAYING FOR SHADE.

Arising out of experiments with Bordeaux mixture on coffee at the Lyamungu Experiment Station the Director of Agriculture (Mr. Harrison) has suggested the investigation of the effects of sprays of suitable duration considered as a means of providing a form of shade. If the effects produced show a parallel relation to those of the usual kinds of natural or artificial shade, the system would avoid the competition of shade trees and the expense of artificial structures. An experiment has been planned to explore the suggestion.

Research Notes

ANTESTIA CONTROL (*Le Pelley, Bull. of Ent. Res.*, Vol. 26, pt. 4, p. 533, 1935.)

Three methods of *Antestia* control are practised in East Africa. Hand-collection (with or without the aid of smoke); poison bait spraying with sodium arsenite and jaggery; and spraying with a paraffin extract of pyrethrum (or dusting with pyrethrum powder).

Without entering into a discussion of the respective merits and disadvantages of the two latter methods, it is desired to call the attention of all interested in *Antestia* control to a paper of some importance dealing with the first method—"Observations on the Control of Insects by Hand-Collection," by R. H. Le Pelley, Entomologist, Kenya Colony and Protectorate. Dr. Le Pelley calls attention to the reasons why hand-collection is a method that finds favour among planters. "The planter believes that every insect caught is one less to eat the crop, and that therefore the value of the method is in direct proportion to the number of insects picked off; he finds it usually an easy method, because he gives it little supervision; he likes it because it entails no capital expenditure; and he observes on occasion that reduction of the pest follows, one such case weighing more in his mind than many where no reduction occurs."

Le Pelley believes however that much of the expenditure incurred in hand-collection is unproductive, and, in the case of *Antestia* on coffee in Kenya, gives reasoned arguments to prove his point. His conclusions as to the uselessness of this method against *Antestia* should not however be applied indiscriminately to all pests under all circumstances. Even with *Antestia* Le Pelley admits that there may be cases of severe attacks in a localized area of the plantation, the rest of the plantation being almost or quite free; and that in such cases hand-picking may be successful. Although he states that such conditions do not occur to-day in Kenya, they certainly occasionally do in the neighbouring territories. Also it should be pointed out that Le Pelley is dealing entirely with *Antestia* on European plantations; small native holdings present different problems, and it would certainly be unwise to instruct their owners that hand-picking is always unprofitable.

It is fairly obvious that in the case of a somewhat elusive bug like *Antestia*, hand-collection can never secure 100 per cent control, and that the rate of increase in the percentage collected, as the time spent on the work is increased, is not constant but decreases continually. It is of interest that in one experiment conducted by Le Pelley this rate of decrease in the efficiency of hand-collection was very close to what would be expected from purely mathematical considerations.

Le Pelley gives one instance which suggests (though it certainly cannot be regarded as proved) that the continual removal by hand-picking of a proportion of the *Antestia* present, when the population was large, even resulted in keeping the population at a more or less constant and relatively high figure, whereas if no control had been practised the population would have reached a peak and then declined rapidly.

In short, Le Pelley considers that he has "de-bunked" hand-collection as a reliable method of *Antestia* control. Anyone (and that should be every coffee planter who is troubled with severe *Antestia* attack) who wishes to analyse Le Pelley's arguments for himself, should consult the original paper, a reprint of which the Kenya Department of Agriculture would no doubt be pleased to supply on loan. T.W.K.

The Conversion of Cotton Seed into Compost and the Disposal of Surplus Cotton Seed

By N. V. ROUNCE, *Agricultural Officer, Tanganyika Territory.*

Cotton seed when mixed with bedding from cattle sheds and subjected to the well-known processes of compost-making as laid down by Howard and Wad, makes an excellent concentrated manure of fine texture. The process which is undertaken at the Morogoro Experiment Farm is briefly described below.

Crop residues are stored for use as bedding in the cattle sheds. Used bedding is withdrawn from the sheds every other day and made up into heaps on the compost factory site, with layers of cotton seed. If there is a concrete floor in the shed, the urine medium is obtained from the urine pit, or, if the floor is of compacted earth, the urine-impregnated earth is scraped from the top three inches about every three months. Slurry is made up of urine water (from the pit) or water and urine earth, and a handful or so of ash, dung and inoculant. The inoculant is the fungus and bacterial medium which is obtained from a heap a stage ahead of the one in preparation.

If the land on which the heap is to be built is dry, it is soaked first with water, then two alternate layers of bedding and cotton seed are spread two inches deep, each layer being moistened with slurry (two pailfuls of slurry are sufficient for one heap). The layers are continued until the heap has reached a height of two feet. Then the whole heap is well watered. If, after a fortnight, satisfactory heating has taken place and fungus growth has spread well throughout the heap, half the heap is turned and watered, and the balance is laid on top and watered again. Inoculant from a month-old heap is spread before the other half is turned over. The whole process is repeated again at one, two and three months. At the third turn it can be carted to the field if convenient and allowed to mature there. If left too long in situ nitrogen is lost at a steady rate.

The cotton seed during the rainy season does not break down to quite the same extent as in the dry months, but all that is left of the hard seed-coat is the black, softened epidermis which soon disintegrates in the field. The decomposition of cotton seed alone by means of moistening it with slurry and turning regularly without the use of bedding has not proved a success.

Where there is a good water supply, bedding from six cattle will enable 80 tons of concentrated manure to be made per year, utilizing more than 50 tons of cotton seed. The cost is not likely to exceed Sh. 2 per ton of compost produced. A heap 14 feet by 8 feet and 2 feet high requires about one ton of cotton seed and the compost produced weighs about 1½ tons; the amount of water required over the period of three months of compost manufacture varies from 500 to 700 gallons per heap. Statistical data of the increases in yield are not yet available.

Ginners might well consider the possibilities of keeping cattle specifically for the purpose of utilizing cotton seed to advantage, which would otherwise be burnt and lost. A ginnery with a 2,000 bale output would produce over 700 tons of seed of which probably 250 tons would be low grade and unexportable; with thirty cattle, this quantity of seed

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Overstocking in Tanganyika Territory

By H. E. HORNBY, *Director of Veterinary Services, Tanganyika Territory.*

Except near the summits of a few volcanoes, every square mile of dry land in Tanganyika Territory is capable of supporting domestic animal life in some form and to some extent; it has, therefore, a stock-carrying capacity. Most of the territory is so sparsely populated by domestic animals that the carrying capacity of these parts continues year after year to be almost unaffected by the grazing to which they are submitted. On the other hand, some of the most attractive parts of the country carry so many stock that as a direct result their carrying capacity is diminishing year by year. Such areas are overstocked, and from their consideration we can arrive at the following definition:—

Overstocking is the maintenance of animals on a piece of land to the detriment of its carrying capacity.

Overstocking with wild game is very rare except where man intervenes, as in game reserves. In this article, however, we shall confine our attention to domestic animals.

Carrying capacity is by no means synonymous with soil fertility; it is a measure of fertility available for production of food for animals under stated conditions. Alteration of these conditions from any cause may lead to changes in carrying capacity. For example, if land under a good grass cover is hoed up and put under cotton, its carrying capacity is thereby diminished, and if it is put under sisal it loses almost all carrying capacity, although there may have been actual improvement in soil fertility. Under changed conditions due to increased human population or merely to increased agricultural activity, a concentration of stock which formerly was not too high may now amount to overstocking, and this, as defined above, further reduces carrying capacity—a good example of a vicious circle.

An obvious corollary to overstocking is under-nutrition, which may be continuous or seasonal, and this, in turn, implies unnecessary suffering and race degeneration. Under these conditions stock-raising becomes a retrogressive pursuit. Thus overstocking is of itself evil, but it is neither on humanitarian nor on genetic grounds that it has aroused storms of public disapproval; what the public are anxious about is the loss of land—soil erosion—which is taking place as the direct result of overstocking.

This phase of the overstocking problem has attracted so much attention that there is danger of loss of perspective. I have no wish to under-emphasise its importance, but I must point out that it is wrong to refer to soil erosion as though it were practically synonymous with overstocking; it may be due to many things, of which an important one is overstocking. If the definition which I have formulated be correct, then the only invariable reaction of the land to overstocking is diminution of carrying capacity, and this may be achieved without loss of soil and even without loss of soil fertility.

In Masailand there is much local overstocking, of which the most prominent result is reduction in carrying capacity through change of vegetation from open woodland to deciduous thicket. In Central Masailand overgrazing has eliminated grass fires and packed the soil; the result is a thickening of the communities of woody plants, a poorer penetration of

rainfall and a greater transpiration rate; this in turn tends to eliminate some species of deep-rooted large trees and to encourage thicket plants. Recent drought years have accelerated this succession, and any traveller between Lolbene and Nabarera can see hundreds of dead and dying *Acacia spirocarpa* as the vegetation is moving rapidly from the Acacia open woodland of less than a century ago to the Balanites—Commiphora-Grewia association of to-morrow. It is debatable if this effect of overstocking is accompanied by loss of either soil or soil fertility.

Of course I know that soil is washed away from a certain number of cattle tracks and that in the immediate neighbourhood of watering-places bare rock gives evidence of loss of soil; but taking Masailand as a whole I maintain, as above, that although overstocking is causing its inevitable administrative problem of how are the Masai to live if their numbers increase while the stock-carrying capacity of their land diminishes, yet it is debatable if the public need be alarmed on the ground that this part of Africa is being irretrievably ruined—it would probably be as near the truth to say that the soil of Masailand is being more and more taken from the Masai cattle and locked up under thicket.

There are occasions when overstocking reduces soil-fertility without soil erosion or plant succession. This is most easily illustrated by drawing attention to what happens on an experimental farm where the feeding values of specific pasture grasses are being determined. In such experiments some beasts are grazed on a pasture plot until they lose weight, and this is repeated year after year. It is always found that, unless manure be applied, the carrying capacity of the plot diminishes year by year through the soil being over-worked, though there has been neither change in the plant association nor loss of soil. An analogous state of affairs exists in patches throughout our overstocked areas, but the condition is obviously unstable and is only mentioned here to emphasise the point so far achieved in my argument, namely that the only inevitable result of overstocking on land is reduction of carrying capacity, and that soil erosion is an important side issue and not an inevitable sequel. The concession of this point in no way affects the fact that overstocking is altogether undesirable from the European point of view; an evil which, wherever found, should be removed if possible.

And yet from the purely native viewpoint overstocking is a necessary evil. Although he does not realize why this should be so, it is the only way by which he is able to maintain a high standard of health among his herds, and it has been deliberately made use of by him from time immemorial. One of the many popular misconceptions concerning overstocking is that this is something new in Africa; something which is due to the successful activities of over-zealous veterinary departments. Actually neither the compliment nor the reproach is deserved; a careful study of the subject permits me to state very definitely that disease control, notably rinderpest control, does little or nothing towards accentuating the bad conditions in the already overstocked areas, since mortality of zebu cattle from uncontrolled rinderpest is less than the usual average wastage from starvation. As long as natives have possessed stock they have been guilty of practising overstocking to the utmost of their ability. In the decades before European intervention there was so much war, pestilence and famine that natives

had many other things to attend to besides the accumulation of stock, and so the total area of this territory which was ruined by overgrazing prior to the middle of last century was not very large. The effect of government by Europeans has been increased peace and security, bringing with them much improved opportunities for accumulating stock, the direct result of which is the overstocking which is so prevalent to-day.

Elsewhere (e.g., 1934 *Ann. Rep., Dept. Vety. Sci. and An. Husb., T.T.*) I have endeavoured to show that the native husbandman is only capable of maintaining large flocks and herds on land the vegetation of which is indicative of arid or sub-arid conditions, since land with persistent vegetation cover favours ticks, flies and worms, against the ravages of which the unaided native is helpless. Therefore because overstocking inevitably tends to produce aridity and to reduce the incidence of parasitic disease, native stock-owners favour it; preferring seasonal losses from starvation, which they can understand, to continual and greater losses from disease, the nature of which is beyond their comprehension. This state of affairs will never rectify itself, and so, for the popular misconception referred to above I wish to substitute the following ideas:—

(*a*) Many traditional native husbandry methods are inseparable from local overstocking with the attendant risk of soil erosion.

(*b*) This deteriorative process is accelerated by *laisser-faire*.

(*c*) The only hope of checking this growing evil lies in some form of Government intervention.

The area of Tanganyika Territory stocked to saturation is about 40,000 square miles and probably 25,000 of these are overstocked, including what was some of the best land of the Lake, Central, Northern and Western Provinces. It has been calculated that this overstocked area is still capable of carrying satisfactorily upwards of two million cattle together with nearly the same number of sheep and goats, and actually it is being asked at present to sustain half as many more. Considering the cattle alone, this means that some 1,200,000 cows and heifers drop 600,000 calves every year on to land of which the carrying capacity is diminishing, so that these births must be balanced by at least the same number of deaths from slaughter, disease and starvation. By the most generous estimate 150,000 is the maximum slaughtered or sold for slaughter, and we cannot avoid the conclusion that an average of at least 200,000 die each year directly or indirectly from starvation. And meanwhile much of the land is steadily or, in places, rapidly, deteriorating.

There is no need for me to discuss what particular class of live stock, when present in excessive numbers, does most damage to the land. The goat is often referred to as though its depredations exceeded those of other animals. I think the reason for this is that this species is more injurious to trees than are cattle and sheep, and that it bears the double blame of destroying both forests and land. This is not quite fair. Leaving on one side areas of evergreen forest in process of spoliation, and turning to the infinitely greater areas of dry forest and open woodland which are being ruined, we find that the goat plays an unimportant part in promoting soil erosion until towards the last stages. So long as there are bushes and herbs on which to browse he nibbles contentedly at these and leaves the grass almost alone. He prunes

and stunts the bushes, but as a rule these are too tough for him to kill; in short he does very little to initiate erosion. This is done by too close grazing by cattle and sheep and by the formation of cattle tracks. After a time when, in conjunction with faulty methods of agriculture, the cattle and sheep have created a wilderness of gullies separated by dry ridges bearing nothing in the way of vegetation but the hardiest of shrubs, then, when the cattle and sheep have departed with the last of the grass, the goat is still to be found, and as he valiantly extracts a livelihood where no other animal can live he undoubtedly makes yet steeper the sides of gullies, and appears to be doing his best to remove the last of the plants and with them the last of the soil. But, in reality, he is merely completing the destruction wrought by sheep, cattle, donkeys and man.

For the purpose of this article, all stock may be classed together. If they are causing deterioration of the land on which they live, this is overstocked, and when we come to consider possible remedies these must be based on principles applicable to stock as a whole.

Too much engrossment with the subject of soil erosion is liable to upset mental balance and to make us forget that, in teleological language, the soil was made for man and not man for the soil. In spite of his abuse of his heritage, the native is more important than the land, and in spite of soil erosion, domestic animals are among a country's most important assets. Let us bear in mind, therefore, that the native is entitled both to live on the land and to possess animals. By succeeding in overstocking he largely removes all menace from such diseases as East Coast fever and trypanosomiasis, and from his point of view he is not benefited if by any action of Government the menace of stock starvation is removed and the menace of disease restored. If we interfere we must do so judiciously, and, by using knowledge beyond that possessed by the native, be sure that removal of the reproach of overstocking benefits not merely the land, but the stock and people as well.

THE REMEDY.

According to the definition given at the commencement of this article, overstocking disappears if there be no impairment of carrying capacity through grazing. In other words, if we can but maintain the carrying capacity of all land used by stock we have found the remedy for our overstocking problem.

Prior to 1931 much thought had been given to the subject in this territory without any suggested solution being accepted by Government as practicable. But meanwhile many palliatives were being attempted. These included education of the native, provision of new grazing grounds, and development of marketing schemes which encouraged the native to sell more of his animals. It was felt though that the main contribution of these palliatives to the problem was to furnish time for the search for a genuine remedy.

It is not certain that a full cure has yet been found, or will be found before the far-off day of individual and intelligent land tenure, but a practical remedy was suggested by Mr. R. R. Staples, Botanist, when in the 1931 Annual Report of the Department of Veterinary Science and Animal Husbandry (pp. 47-53) he discussed the Usukumu Overstocking Problem and put forward a proposal concerning Rotational Grazing.

Since then this proposal has been examined very carefully, not only by

the Department chiefly concerned but by several Provincial Commissioners as well, and the main principles of the scheme have met with general acceptance.

Briefly the scheme is this: Although 25,000 square miles of the Territory are overstocked, this is a small proportion compared with the remainder which is either understocked—owing principally to enzootic East Coast fever—or practically without stock, owing to tsetse fly and/or lack of water. The scheme does not attempt to touch the fly-free, well-watered, under-stocked areas; chiefly mountain grassland; it is concerned with areas overstocked or fully stocked, and with contiguous areas at present without stock at all. As stated above this absence of stock is due to either lack of surface water or the presence of tsetse; if the former, then there is obviously paucity of human inhabitants as well. Now there are few parts of the territory with an average annual rainfall of less than 20 inches, therefore few parts where simple shallow catchment dams will not conserve abundant water for stock throughout and for a month subsequent to the short rainy season of about five months. If, then, for every three square miles of overstocked land, which is essentially land served by permanent water supplies, one-half to two square miles (according to grass cover) of uninhabited savannah or grassland be made available to stock during the rainy, i.e., the growing, season, and if the stock use this during the rainy season and use the land near permanent water only during the dry season, then it is thought that land thus rested completely for six months need not suffer further loss of carrying capacity even though grazed bare during the months of use. If this be so, then overstocking is abolished wherever the practice is applied thoroughly.

The main attraction of the scheme is that it does not entail the compulsory reduction of any man's herds and flocks; it merely provides for the compulsory use by all animals of two pieces of land instead of one.

There are many difficulties to be overcome before this scheme can be applied to every overstocked part, but none is insuperable. Some of them are inherent and therefore general; others are purely local.

Some of the inherent difficulties are:

(*a*) Finding areas unused by stock at present which can—with the help of the Tsetse Research Department and/or the Geological Division of the Lands and Mines Department—be turned into wet-season grazing grounds.

(*b*) Getting the necessary fly clearings and/or dams made.

(*c*) Deciding which units of stock shall use this grazing. Arranging that these units and no others use it.

(*d*) Evacuating these stock units at the right time.

(*e*) Preserving unmolested and unburnt for the owners of these units, the land which is being rested.

(*f*) Arranging for the exception of a few bona fide milking cows from the scheme, if these be required at villages during the time the main herds are on the wet-season grazing.

These, and local difficulties, may be considered in a little more detail if we review what has already been done towards maturing the scheme in (1) Masailand, (2) Usukuma.

(1) *Masailand.*—A few years ago the idea prevailed that the Masai should be

encouraged to abandon their nomadic existence, and a certain amount of satisfaction was expressed when it was related how this, that, or the other group of Masai rarely moved from the neighbourhood of a permanent water. To me this trend of affairs was alarming. When I visited the areas of these settlers I found evidence of the grossest overstocking, the only redeeming feature of which was —as stated early in this article—that since there was no cultivation the reduction in carrying-capacity was due mainly to plant succession from open woodland to thicket, rather than to soil erosoin. As I wrote in my contribution to a "Memorandum on the Economics of the Cattle Industry in Tanganyika" (pp. 5 and 6): "It may be that it would be in the ultimate interest of the Masai if they forsook nomadic pastoralism to become stationary agriculturalists, but it is almost certain that under existing conditions such a change would mean the loss of the greater part of their cattle and the rapid deterioration of all pasture in the neighbourhood of their settlements. The immediate best interest of the Masai is served by complete nomadism; what we deplore at the present time is a partial nomadism by which the majority of herds move away from the permanent waters when the rains permit, but a minority remain. This minority does incalculable harm: If only all would move away, then the pasture could regenerate and be completely re-established by the time the temporary waters of the plains dried up; also the absence of all cattle for six months, whether or not they were replaced by a few game animals, would go a long way towards cleaning an area from East Coast fever (when an infected tick feeds on animals other than cattle it loses its infection; hence game, sheep, goats and donkeys can be important factors in eliminating East Coast fever from an area). If a few herds remain, these spoil grass regeneration and encourage bush, they tend to maintain East Coast fever in severe sporadic form, and they encourage the nomads to come back to the permanent waters before being driven back by drought. So long as the Masai remain largely, or better, completely nomadic, then by making the utmost use of rain ponds they can generally obtain sufficient grazing and avoid heavy losses from East Coast fever, and their big problem is tsetse encroachment."

My warning was received most sympathetically by the provincial administration, and tentative approval has been given of the policy which seeks to divide the Masai into groups each of which has its dry-season and wet-season grazing; the latter to be provided for in ever-increasing quantity by building one or more large dams each year. It is felt that with these people, whose whole life is bound up with their stock and who are prepared to endure hardship and danger in the interest of their animals, there will be no difficulty in getting them to accept the most important principle of the whole scheme—the complete resting of more than half the grazing during the whole of the growing season. In further compliance with the demands of the scheme, alien squatters will not be allowed to cultivate near permanent water in fly-free areas; the growing need of the Masai for grain will be met by this being brought in by lorry along improved motor roads, and paid for by money from stock which pass to markets along routes with improved provision of water and grazing.

(2) *Usukuma.*—Until recently a great deal of excellent *mbuga* grazing was denied to the stock of the Lake Provinces by light "fly" and/or absence of surface

water. See, in this connection, the "Report on the Huru-huru Mbuga" by Staples (loc. cit. p. 51). Years ago, before rotational grazing had received any attention in this country, the possibility of reclaiming this land had been demonstrated by the Administration and the Tsetse Research Department. Here again the success of the reclamation was qualified by the immediate abuse of such reclaimed land as lay near permanent water, and the comparative neglect of the grazing which could be used only during the rains. Obviously the main difficulty to be overcome in instituting rotational grazing as a regular feature of Usukuma husbandry is the disinclination of the stockowners to send their animals away from their villages at the very time there is grazing in the neighbourhood. This difficulty was fully realized and it was essential that prejudices and fears should be removed, first by demonstration with small herds of animals under Government control, and secondly by getting certain chiefs and wealthy stockowners to give a lead. The demonstrations have been made successfully (see Staples, "Demonstration of Rotational Grazing" 1934; Ann. Rep. of Dept. Vet. Sci. and An. Husb., p. 127), and that the stage is set for the next stage is announced in a recent letter to me by Mr. C. McMahon, Acting Provincial Commissioner, Lake Province. He writes: —

"I have the honour to refer to your letter No. 502/25 of the 25th of September on the subject of policy regarding overgrazing in this province. During my recent visit to Shinyanga, Maswa and Kwimba I discussed this matter with the District Officers and several of the leading Sukuma Chiefs. As the result of our discussion I have come to the conclusion that there would be no great difficulty in persuading wealthy stockowners (Chiefs and others) to utilize the areas now available for wet-season grazing. I refer to the Huru Huru, Wida and Buhungukira areas. As you are aware many of these wealthy stockowners have grazing areas in the vicinity of their houses which can be regarded as private reserves and therefore can be rested.

I feel sure that if we have the services of an energetic and tactful officer to handle the situation, we could achieve some success and I would ask whether you could second an officer to undertake this experiment during the coming year. My suggestion is that we should endeavour to get certain chiefs and wealthy stockowners to go into these areas, and at the same time get a corresponding area rested.

To commence with it will be necessary for your officer to examine the grazing available at each of these three areas and determine how much stock these can carry. Thereafter sufficient stockowners will have to be induced to agree to go into these areas. The next consideration will be to arrange for the evacuated areas to be put out of bounds. I do not know these clearings sufficiently well enough to express an opinion as to their carrying capacity but I believe we shall have no difficulty in getting 50,000 or even double that number of stock to move into them. The number of owners will not be many and therefore no great difficulty should arise in dealing with them. My idea is to aim at getting those who own 100 or more head of cattle to start with.

This suggestion is in the nature of a large scale experiment and we should gain valuable information as well as experience for future operations. So much has been written on this subject and we all agree on the policy, but little appears to have been done to put it into practice on a large scale and I consider that the opportunity should now be taken to try out the experiment on a large scale, particularly as the Chiefs are enthusiastic and also the areas referred to are comparatively 'virgin' grazing land.

I have no officer available to detail for this important work but I can assure you that the District Officers concerned are fully aware of the necessity for close co-operation and will render every assistance to your officer, if you can spare one, to carry out the detailed programme. No expenses will be involved other than the salary and transport of your officer and in respect of the latter I will instruct my

District Officers to place any reasonable transport facilities available at his disposal.

I feel sure that the other issues raised in your letter under reply can be more easily dealt with after we have had an opportunity of studying an experiment on a large scale and ascertaining the real attitude of the Chiefs and wealthy stock-owners. The Sukuma have always been led by their Chiefs and I am of the opinion that if we are ever to succeed in our attempts to overcome this gigantic problem, we must get those in authority to practice what they preach; hence this request. You offer me assistance in paragraph 4 of the letter under reply and I now ask for this to enable me to start this important work by educating those who must ultimately be responsible for carrying it on, viz., the Chiefs and their Native Authorities. Any hope of success must rest with them rather than with our small European staff, who can at most be no more than advisers to the stockowners over such an important issue.

The Annual Communal reclamation turn out should embody such works as anti-soil erosion measures, water supply in the form of earth dams, re-afforestation; in fact anything pertaining to the preservation of the soil and not merely bush clearing. I am instructing the District Officers to discuss with their Chiefs and Native Authorities the question of undertaking all or any of these measures with the annual communal turn out. Only by so doing can we hope to make the natives realize the value of preserving their heritage."

In response, an Assistant Live Stock Officer, has been sent to the Lake Province for the express purpose of inaugurating the scheme.

Some years must elapse before any results are apparent. Also, maybe, some serious flaw has been overlooked. But meanwhile no critic can truthfully say that with regard to the Overstocking Problem in Tanganyika Territory, the official attitude is "I came; I saw; I deplored, and I went away".

SUMMARY.

Overstocking is defined as "The maintenance of animals on a piece of land to the detriment of its carrying capacity."

Since diminution of carrying capacity may occur without loss of soil or soil fertility, soil erosion is not an inevitable sequel to overstocking; it is, however, a common sequel and the one which makes the solution of the overstocking problem an urgent necessity.

From the purely native view-point overstocking is a necessary evil. It is the only way by which he is able to maintain a high standard of health among his herds, and he prefers periodic losses from seasonal starvation to continual losses from parasitic diseases. The inevitable tendency of uncontrolled native husbandry is towards the two extremes of overstocking and complete absence of stock. The only hope of checking this growing evil lies in some form of government intervention.

At present about 25,000 square miles of Tanganyika Territory are overstocked, but 250,000 square miles are almost without domestic animals.

The remedy lies in evacuating overgrazed land during the whole of the growing season. To permit this, a corresponding though considerably smaller area of land which is at present without stock must be made available during the same season, by provision of catchment dams and by tsetse reclamation.

To effect this, many difficulties must be overcome, but in the opinion of those who have examined the scheme most carefully none is insuperable. Accordingly a start has been made.

Feeds for Live Stock

By M. H. FRENCH, *M.A., Dip. Agric., (Cantab.)*

The food eaten by an animal has two main functions to perform, it has (*a*) to supply the specific substances for the repair of tissues and to supply the energy needed for movement, digestion, and maintenance of body temperature etc., and (*b*) to supply the raw material from which the animal builds up tissues, and forms secretions such as milk, or converts into work. For the past century scientists have been endeavouring to establish a relationship between the amount of food eaten and the resulting production in the form of milk, work, or live-weight gain. The results of these labours are summed up in the various tables of feeding requirements that are published in all text books on the feeding of live stock. These tables give the quantity of digestible protein and energy an average animal requires if it is to maintain its weight and condition. They also state the amount of energy and protein that it is necessary to feed for the production of 1 gallon of milk, or 1 lb. live-weight increase, etc. It is not intended to recapitulate all or any of these feeding standards; any farmer may look them up for himself in any book dealing with the feeding and management of live stock. It is with the practical application of these standards that the following notes are concerned.

When one visits the farms in East Africa one finds some farmers rationing their live stock along modern lines and making the utmost use of the feeding standards that have been worked out. These notes are not intended for such up-to-date settlers but rather for those who are attempting to feed balanced rations but find their application too expensive, and for those farmers who do not attempt to follow scientific methods. All intermediates are found between the highly efficient modern dairy farms and the dairy farms where high grade European animals capable of yielding two or more gallons daily are given very little, if any, supplementary feeding, and may even be maintained under ranching conditions.

One of the weaknesses of human nature is the craving for short cuts, formulae and recipes. Many of those farmers who have found scientific rationing incompatible with economic feeding are possibly subconsciously suffering from this craving. The feeding standards as laid down by the various European and American workers are average values only, and must not be regarded as the ideal for all conditions. The feeding standards are of a very elastic nature and must only serve as guides. Each farmer should base his feeding on these standards and then make such modifications as are necessary to suit the idiosyncrasies of his stock, the market prices of his produce and the food-stuffs available locally in large quantities.

Rations must always be designed with strict reference to their cost in relation to the market values of the live stock produce. This means that the more feeds a farmer can grow the less expensive will his rationing become. A ration computed from home-grown feeding stuffs alone will usually be deficient in proteins and it will often be found necessary to buy some food-stuff of high protein content.

Those farmers who do not feel inclined to go in for intensive farming, or who do not feel they can afford to buy concentrate foods for their stock, can, however, grow many protein-rich food-

stuffs. Many dairy farmers in Tanganyika give their milking cows no supplements, whilst others limit the supplementary feeding to the provision of a little silage, a soiling crop, or perhaps the bean or pea haulms from crops grown for human consumption. All these farmers would be well advised to grow leguminous crops and use the seeds for concentrate feeding and the haulms as hay when the dry-season grazings are eaten out.

In the Southern Highlands the farmers, who are going in for pig rearing, are attempting to grow as many of the pig foods as they are able, and by this means the use of meat meal will be reduced to a minimum and possibly dispensed with altogether. Animal protein is the most suitable way of adding protein to a pig's ration yet the transport charges in connection with this product make it very doubtful whether meat meal will be an economic feed around Iringa.

Scattered over this Territory are a number of small oil mills, and farmers should make the utmost use of the residues from these mills. So long as they are fresh they constitute a highly digestible and palatable protein concentrate. They cannot be stored, however, because the crude oil-extracting apparatus often leaves much oil in the residues and these are then liable to become rancid very quickly.

Many hundreds of tons of cotton seed are burnt annually in this Territory. Cotton seed forms an extremely valuable food for cattle, sheep and goats, and insufficient use is made of this valuable feed. Many farmers are afraid that the lint attached to the seeds will cause digestive disturbances and even obstruction of the alimentary tract; such fears are groundless, and the Veterinary Department feeds cotton seed every year to its dairy cows, cattle, sheep, and goats. Very few animals indeed ever refuse this food when offered for the first time, and quantities of up to 10 lb. per day will be regularly consumed by cows in milk and also by other classes of cattle.

There are many other industrial by-products which farmers in certain districts may purchase very cheaply. Such feeds are the by-products of the rice and flour mills, molasses, carcase meals, and brewer's grains. The number of farmers sufficiently close to such mills or factories is very limited of course. Most farmers, however, are able to purchase maize or millet bran from natives for a few cents a *debi*. The residues from the production of native beer are readily obtained in most districts. Groundnut tops can be purchased cheaply in those areas in which this crop is grown.

There are many locally produced feeding stuffs which can be obtained cheaply and easily from the natives, and farmers should make as much use of these as possible. It may be claimed that in doing so the European farmer is depriving the native of food for his own stock. The answer is that at present the native does not use these by-products to their full extent, and the best way of teaching him to do so is for the European settlers to show him that these by-products are worth purchasing.

The reason that fuller use has not been made of the above native by-products is often that farmers do not realize their value or how to feed them. Plate I is an attempt to show diagramatically how to feed the most commonly available East African feeding stuffs.

It is difficult to divide up the foodstuffs into groups because of overlapping, and because of the difference the cost of a food can make to its suitability for stock feeding purposes. I have shown a

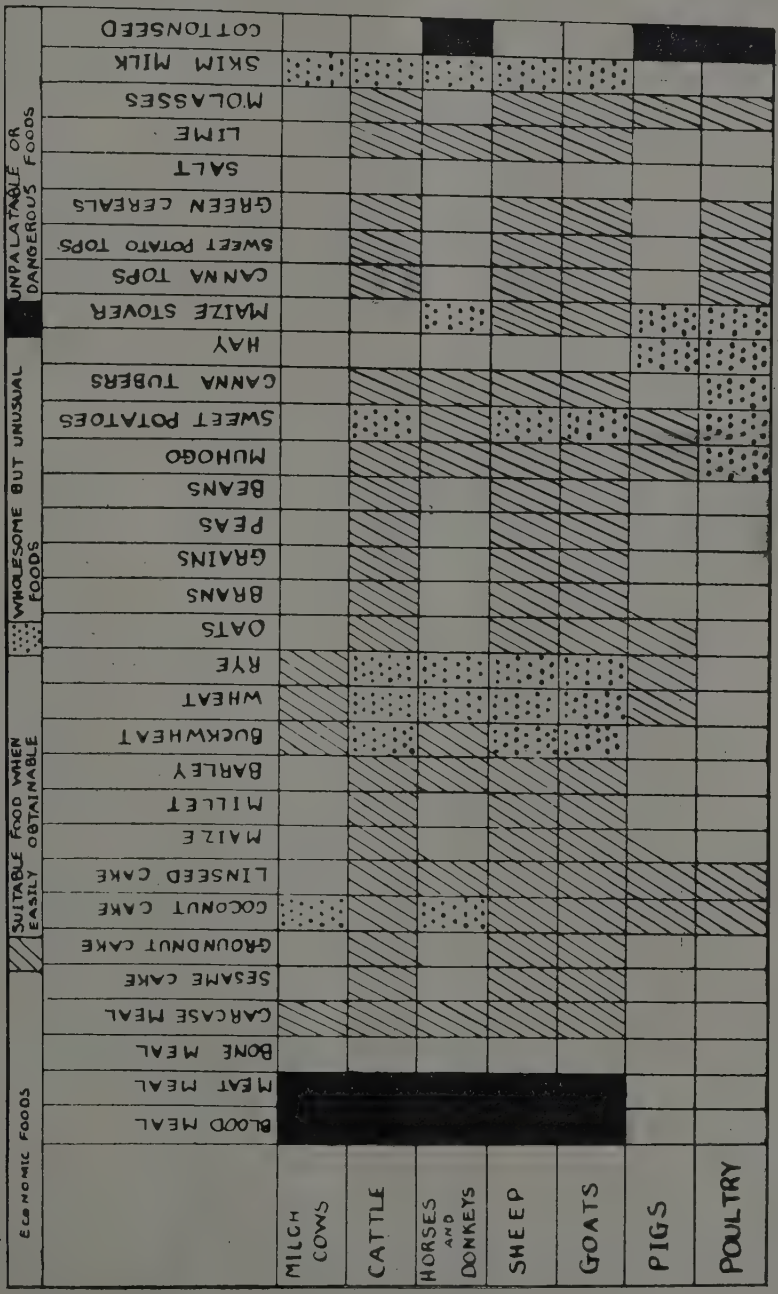
ECONOMIC FOODS
BLOOD MEAL
MEAT MEAL
BONE MEAL
CARCASE MEAL
SESAME CAKE
GROUNDNUT CAKE
COCONUT CAKE
LINSEED CAKE
MAIZE
MILLET
BARLEY
BUCKWHEAT
WHEAT
RYE
OATS
BRANS
GRAINS
PEAS
BEANS
MUHOGO
SWEET POTATOES
CANNA TUBERS
HAY
MAIZE STOVER
CANNA TOPS
SWEET POTATO TOPS
GREEN CEREALS
SALT
LIME
MOLASSES
SKIM MILK
COTTONSEED
SUITABLE FOOD WHEN EASILY OBTAINABLE
WHOLESOME BUT UNUSUAL FOODS
UNPALATABLE OR DANGEROUS FOODS
MILCH COWS
CATTLE
HORSES AND DONKEYS
SHEEP
GOATS
PIGS
POULTRY

PLATE 1

number of food-stuffs as capable of being fed economically to the various classes of stock. This is conditional on those food-stuffs having an average market value and not carrying heavy transport costs. For instance cotton seed in the neighbourhood of a ginnery is a ridiculously cheap feeding stuff but when carried several hundreds of miles by rail or lorry becomes a very much less attractive food.

The division of food-stuffs into "economic foods" and "suitable foods when easily obtainable" is a very labile one, and much overlapping occurs. Foods at the extreme of each group such as salt and wheat are easily placed, though foods near the dividing line such as oats or barley for milking cows hold debatable positions. In these latter cases the farmer must use his knowledge of the ruling market prices before he makes up his mind to use these foods.

There is another but less marked overlap between the "suitable foods when easily obtainable" and the "wholesome but unusual foods". Rye is here holding a debatable position though there is no doubt about the position of skim milk for feeding to dairy cows.

The grouping into "unpalatable or dangerous foods" includes unpalatable foods chiefly, though the feeding of cotton seed to pigs for instance is usually regarded as a dangerous practice.

NOTES ON THE EAST AFRICAN FEEDING STUFFS.

The following notes are intended to be of a qualifying nature to explain the position of the food-stuffs in the different groups in Plate I.

Cereals.

Oats.—If well filled, oats form an excellent feed for all classes of stock, and in this respect are the best of the cereals. In East Africa only a limited quantity is grown, and often the grains are not well developed. Their limited availability makes them suitable for only the high-production animals.

Barley.—Barley comes next to oats in feeding value when the grains are well filled. In East Africa they are often very fibrous owing to under development. Barley meal has a most marked and highly beneficial effect on the quality of bacon.

Wheat.—This cereal is usually far too expensive for feeding purposes. Often however all the small and cracked grains become available and can be fed to all classes of stock though on account of cost in East Africa it should only be fed to dairy cows, poultry and pigs.

Rye.—Very similar in composition and uses to wheat.

Maize.—Is the most commonly grown cereal in East Africa and is the one most extensively used for feeding to all classes of stock.

Millets.—Form a good food for all classes of stock though some varieties have very hard coats and need to be ground before feeding.

Buckwheat.—This cereal is grown in certain localities. In composition it is a little more fibrous than oats. The grains are usually well filled in East Africa. Buckwheat must never be fed in excessive amounts, otherwise skin eruptions or other untoward results may be obtained. It gives a very white colour to the flesh of poultry.

Cereal By-products.

Brans (wheat, maize and millets).—Brans are fed not so much for their nutritive properties as for their physiological effects. They form a "cooling" ration and produce a slight laxative effect.

Brewers' grains.—Grains are a good feed for cattle and horses but are too fibrous for pigs and poultry though these latter eat the grains with relish.

Leguminous Seeds.

Peas and beans of many varieties are grown in East Africa but chiefly for human consumption. They form valuable protein feeds for all classes of stock. They must not be fed in too large amounts as they possess definite "heating" effects.

Oil Seeds and their By-products.

Cotton Seed.—A most valuable food for cows, cattle, sheep and goats.

Sesame Cake and Groundnut Cake.—These oil-mill residues form valuable protein concentrates. They can be fed with safety to all classes of stock though obviously it is more economical to feed them to the higher producing animals.

Coco-nut Cake.—This is a wholesome food but contains much less protein and much more fibre than either sesame or groundnut cakes.

Linseed Cake.—This cake is obtainable fairly easily in some parts of Kenya. It possesses a great reputation as a stock food. Farmers should be careful not to pay for the reputation as well as for the cake.

Animal By-products.

Meat Meal and Blood Meal.—The by-products of this territory are not palatable to most stock but form highly concentrated protein supplements for pigs and poultry. Poultry often do not eat blood meal, and young pigs are very liable to scour badly when fed this food.

Bone Meal and Carcase Meal are useful supplements for all classes of stock. If carcase meal is not properly made, difficulty may be experienced in persuading certain types of stock to consume it readily.

Skim-milk.—This by-product of the dairy industry forms a most valuable food for pigs and poultry.

Roughages.

Hay.—Hay made from grasses or legumes forms a most necessary stand-by for the dry season on all farms where intensive farming is being practised.

Maize Stover.—A good filling food for stock except horses, pigs and poultry.

Green Maize, Canna Tops, Sweet Potato Tops, etc.—These soiling crops are invaluable for providing succulent green foods to stall-fed stock. When irrigated they are most useful during the dry-season feeding of dairy stock.

Muhogo.—The sweet variety makes a very good root crop for stock-feeding purposes in seasons of plenty. In season of famine it is more profitable to sell it for human consumption.

Salt.—This is needed by most classes of stock though only a very limited amount should be fed to poultry as birds are very susceptible to salt poisoning. For this reason it has been included in the "unusual" food-stuffs of Plate I.

Lime.—This can often be purchased cheaply and then forms a very good mineral supplement for pigs, cows and poultry.

Molasses.—Molasses in the neighbourhood of sugar refineries is an attractive food-stuff. It often encourages animals to eat food they would otherwise refuse and in this way its use is often abused.

CONCLUSIONS.

It will pay farmers to feed their stock up to their productive capacity, but to underfeed or overfeed will prove uneconomical.

(*Continued on page* 383)

Bukoba Coffee: Inspection and Grading

By T. S. JERVIS, *Senior Agricultural Assistant, Tanganyika Territory.*

The object of grading any commodity for market is to achieve recognized standards of quality on which trade may be based, so as to afford buyers a degree of security in regard to the quality of their purchases. This security stimulates demand, and competitive prices result which help the primary producer. It was to attain this object that Government introduced the inspection and grading of coffee in Bukoba in 1932, when the need for action became imperative owing to the fast waning interest of the more profitable markets.

In order to appreciate the urgent necessity that had arisen, it is necessary to review briefly the coffee industry in Bukoba, up to the stage of development attained by 1932.

Trade in Bukoba coffee commenced in 1898 when the first parcels were sent as porter loads overland, via Tabora to Dar es Salaam, and thence to Aden. By 1905 the industry had been fostered sufficiently to warrant one of the Lake steamers calling for cargo. 234 tons were shipped that year and Mombasa merchant houses becoming interested, immediately appointed agencies in Bukoba. It will be remembered that in 1905 there was very little East African coffee offered for sale, so that there was keen competition for all that Bukoba could produce. The buying houses established in Bukoba township opened sub-agencies in the interior of the district and extended fanwise, with native buyers, over the entire producing area. A house to house collection of dry cherry ensued, and the foundations of our internal marketing system were laid.

Coffee indigenous to the country was planted throughout many of the existing banana plantations, and the crop increased from 2,563 tons valued at £116,678 in 1923 to 7,837 tons valued at £478,311 in 1928. With the extension of production, commercial activity quickened, and big business on a speculative basis commenced. Mombasa merchants now began to sell forward, at the same time contracting with Bukoba traders to buy in, and ship by a given date, sufficient coffee to cover their commitments. There was no recognized standard of Bukoba coffee, and local exporters accepted no responsibility in regard to the quality of their shipments.

Meanwhile, cultural work in the field suffered a set-back. The native grower, finding there was a ready sale for his produce despite its unsatisfactory condition, ceased to take interest in the proper maintenance of his plantation, thereby encouraging the spread of disease and pests. Not being obliged to prepare his crop, which he sold as *buni* (dried cherry) regardless of quality, the outturn by weight of bean did not concern him. All being of equal value, he collected impartially anything he could lay hands on—ripe, over-ripe, unripe, borer damaged, diseased, and, in fact, any kind of coffee, and sold it to the itinerant trader who called at his door.

We arrive then at a stage where plantation neglect had produced a pest-ridden and defective bean, mixed with all manner of extraneous matter, dust, stone, husk, and sometimes even water was added. This was then exported as a fair average quality of the season's coffee. Mombasa merchants bought this coffee in bond, and shipped it, sometimes without satisfying themselves as to its quality; overseas buyers refused to accept such

consignments, and thousands of bags had to be destroyed. The matter was submitted to arbitration and Mombasa had to bear the entire cost. The loss sustained by our salesmen in Mombasa cut us out from profitable markets, and the fall in demand for Bukoba coffee became serious. The value of the crop fell from £478,311 in 1928 to £133,260 in 1931, with a drop of 1,251 tons in the exports for that year. Confidence in the quality of the Bukoba produce was lost and Government intervention became imperative, and, despite some opposition, the Bukoba (Coffee) Export Regulations were implemented in 1932.

Under the regulations all coffee exported from the Port of Bukoba had to pass a test of quality, ensuring that the coffee did not contain more than 2 per cent extraneous matter, or 12½ per cent moisture. All bags so passed were stamped with a large red T in a circle, denoting the minimum requirements of the trade, namely dry and unadulterated coffee material. The regulations further aimed at establishing a fair average quality which could be prepared economically by the local trade, would be acceptable to the markets abroad and could compete in price with similar grades of coffee produced elsewhere. In consultation with the trade, a "FAQ" (Fair Average Quality) standard was evolved, which allowed for certain characteristic features being retained. It fixed the percentage of defectives, both by weight and by count and reduced extraneous matter to one-half of 1 per cent by weight, thus bringing Bukoba coffee on a par with that from Brazil: Bukoba "Native" then compared favourably with Rio No. 7/8, and "Plantation" with Santos No. 4/5. The term "grading" as used in the coffee trade, usually means that a parcel has been sized and divided into the recognized grades of "A", "B", "C", whereas grading under the Tanganyika regulations aims at maintaining the standard quality of "FAQ" and is not, strictly speaking, "grading".

Consignments of "FAQ" usually consist of 57 bags of five tons, each bag weighing aproximately 203 lb. The bags are stacked in lots of six, one on top of the other, with both ends exposed for inspection. A fluted spike, 24 in. long, is driven in and samples are drawn off from one end and from the middle of each bag. These two samples are then put together into one of six compartments in a tray, each being numbered so as to represent its position in the lot under inspection, whilst the tray itself is numbered to correspond with one of the lots of six in the parcel submitted for inspection and grading. The contents of each compartment in each tray, are dealt with separately, and the bags are marked with their respective grades. Every bag of coffee stamped "FAQ" carries a guarantee of quality, and a signed certificate to this effect is given.

With a sympathetic understanding of contract obligations, the exporters were encouraged to improve the quality of their shipments. Grading was not obligatory and it was not until there was a full season of successful work behind us (a period of nine months in which we examined 78,358 bags and graded 65,706 bags) that the trade felt satisfied as to the reliability of the measures taken. By January, 1933, the "FAQ" certificate had been accepted as the basis of all contracts abroad, and brought with it a renewed demand for Bukoba coffee. In spite of the general fall in world coffee prices, an increase of £5 per ton on "Plantation" and £2/10 on "Native", covering the year's exports can be recorded.

Coffee falling below the standard of our "FAQ" ceased to interest buyers, and local exporters had, perforce, to ship nothing but the standard grade. In order to prepare their coffee up to the standard required by Government, they installed small winnowing machines to separate and clean out extraneous matter. Economically, they were obliged to discriminate in their district purchases, and the buying price of coffee offered for sale in the villages varied accordingly. Slowly but steadily the pressure at the grading shed exerted its influence on the producer; and with the combined help of technical and administrative officers the native was made aware of the benefits of plantation sanitation, of improved cultural methods and pest control.

The following table shows the tonnage and value of exports for the years 1924-34:—

Year	Exports in Tons		Value
	Plantation	Native	£
1924 ..	662·11	2,869·07	234,026·55
1925 ..	1,572·86	2,578·30	320,745·94
1926 ..	1,020·53	3,579·17	324,083·98
1927 ..	1,374·63	2,569·11	215,844·56
1928 ..	2,582·63	5,254·33	478,310·94
1929 ..	2,072·79	4,721·49	400,010·92
1930 ..	2,708·46	4,660·10	194,011·48
1931 ..	1,738·29	4,848·10	133,260·76
1932 ..	1,401·27	5,705·92	264,784·46
1933 ..	2,868·06	5,054·02	227,006·08
1934 ..	3,331·04	6,898·50	329,682·30

It can fairly be said that the measures for inspection and grading of Bukoba coffee have been fully justified, and have resulted in the re-establishment of the industry with benefit to all concerned. Because of the regulations it became possible to offer quality coffee in bulk, trade was stimulated and demand for Bukoba coffee was revived. Competitive prices for well-prepared parcels now provide the right incentive to better cultural measures being adopted without resorting to prosecution under the Plant Pest and Disease Regulations, and the grower obtains a higher output from his hulled cherry and a ready sale for all he can produce. The Indian trader no longer views with suspicion the inspection of his consignments, but accepts with confidence the decision of the grader. The Mombasa buyer and shipper has a facility in the Government guarantee which relieves him of a great deal of anxiety and permits him to trade in this commodity without any fear of loss through supplies of indifferent quality.

Acknowledgment is due to the Bukoba Chamber of Commerce, and to the Coffee Section of the Mombasa Chamber of Commerce who have given valuable assistance and advice regarding all matters which have pertained to the measures taken.

(*Continued from page* 411)

Mixed Farming in East Africa

a deep milking cow should not consist too largely of meals, but should include also a fair percentage of less finely divided substances such as cakes and dairy cubes of any reputable local brand. Such foods are prepared carefully in a balanced manner and are put up in the form most digestible to the stock.

The potentialities for dairying of the areas which have been dealt with are great, provided that full use is made of both arable and grassland for the feeding of the stock.

The Establishment and Maintenance of a Pure Supply of White Sesame Seed

By R. B. ALLNUTT, *Agricultural Officer, Tanganyika Territory.*

INTRODUCTION.

A commercial sample of sesame (*Sesamum indicum*), known in Kiswahili as *ufuta*, consists of a mixture of seeds of many different colours. White predominates, but there are usually some yellow, buff, brown and black seeds as well. The higher the percentage of dark seed, the lower is the commercial value of the sample. At present the grade known as white/yellow (containing a low percentage of dark seed) is worth about Sh. 25 a ton more than the grade known as "mixed" (containing a relatively high percentage of dark seed). Pure white seed, unmixed with any coloured grains, is not yet obtainable in commercial quantities, but local traders have expressed the opinion that if such seed were shipped in, say, 50 ton lots, it would fetch Sh. 10 a ton more than the white/yellow grade. Should this eventually be disproved, and pure white fetch no more than white/yellows, it would nevertheless still be important to areas now growing white/yellows that their produce should be kept up to standard, and not allowed to deteriorate, as has already happened in some parts of Tanganyika Territory, and obviously it would be to the advantage of districts at present producing "mixed" grade to bring their sesame up to the white/yellow standard or higher. In fact all districts growing sesame, whether of high or of low quality, would gain by the elimination of dark seed. With this object in view, investigations have been made in the Southern Province, chiefly at the Mpapura Agricultural Station, and it has been found that it is a fairly simple matter to obtain a pure supply of white seed, which breeds true. The methods employed are detailed in Part I of this article.

No practical experience has yet been gained in the large scale multiplication of pure white seed, its introduction to the cultivator, and the maintenance of purity over a district as a whole after the original introduction. But it is possible to foresee some of the difficulties that are likely to arise, and to suggest ways of meeting them. This aspect of the subject is discussed in Part II.

PART I.

How to Obtain Pure White Seed.

(*a*) *Plant Selection.*—The easiest way to obtain an initial supply of pure white seed is to select white-seeded plants from a field of standing sesame. Such a field will normally consist of a mixture of plants of sundry varieties or strains with variously coloured seeds. All these plants are externally indistinguishable from one another; we have not, at any rate so far, discovered any particular flower-colour, leaf-shape, habit of growth, or other morphological feature associated with seed of any particular colour. From the external appearance of the plant it is not possible to determine the colour of the seed. It is necessary to examine the seed itself. Fortunately the sesame plant is nearly always self-fertilized; natural crossing does occur, but only rarely.

Therefore the seed of a normal plant is uniform in genetic composition, and, within limits, in appearance. In coloured-seeded plants the intensity of pigmentation of the seed may, for some reason not known, vary from pod to pod on

the same plant. Furthermore the terminal pods are apt to be poorly developed or diseased, and hence to contain abnormal seed. For instance, the terminal pods of black-seeded plants often contain seed which is almost white. This may be due to the pod drying out before the seed has fully developed its pigmentation. Similarly, the terminal pods of white-seeded plants may contain stained, greyish seed (probably affected with mildew) or thin yellowish seed (imperfectly matured). Pods in other positions on the plant may be somewhat similarly affected, but in their case it is generally only the tip of the pod which is abnormal, the lower half of the pod containing seed typical of the plant in question. With the foregoing exceptions it has been found that every seed in a given pod is of uniform colour, and every pod on a given plant contains similar seed. It is either all white or all coloured. Therefore one need only examine a single sound pod to determine the colour of the whole plant. The plant must, however be ripe, not necessarily dry, but fit to harvest. If immature plants are examined there is a risk of errors being made, because the pigment of coloured seeds does not develop fully until the plant is mature. To be on the safe side, it is best to wait until a few of the ripest pods are just beginning to split and then to examine not less than three sound pods situated near the middle of a healthy branch. If these contain white seed, the whole plant is white and can be saved for seed; if they are coloured or doubtful the plant should be rejected. (N.B.—Never judge by terminal pods or those on which traces of disease are obvious.)

The mature, but still sappy pods are easily split with the thumbnail, and the process of examination is quite rapid. If only a few ounces of seed are required it is best to examine standing plants. This enables one to choose vigorous, healthy plants of outstanding merit apart from the colour of their seed. But if large quantities of seed are needed, it is better to have the necessary quantity of plants cut and bundled and carried to a shady place, where they can be examined at leisure and sorted out. The plants selected for seed should then be re-tied into sheaves and placed on a drying rack until fit to thresh.

It should be mentioned that the selection of white plants is naturally very much easier if the crop is left standing until the stems begin to dry out and the pods have all split. In this stage a glance is enough to determine the colour of a plant, but the harvesting is difficult to perform without the loss by shedding of a large proportion of the crop. It is very wasteful. There is the added disadvantage that it is quite common for a few coloured seeds, when shed, to lodge in the open pod of a neighbouring white plant, and thus to contaminate the seed saved.

Selection of plants while still in the sappy stage will give a hundred per cent pure supply of white seed if all doubtful plants are discarded. Ordinary casual labourers can be taught quite quickly to carry out the whole job.

(*b*) *Handpicked Seed.*—An alternative method of obtaining an initial supply of white seed is to handpick an ordinary commercial sample of seed, removing all coloured grains. This method is less reliable than the one described above, because of the difficulty of distinguishing between a slighty discoloured white grain and a very pale "dark" seed. It was mentioned above that the terminal pods of dark-seeded plants are apt to throw whitish seed. No tests have been done with such seed,

but, if it is viable, it will almost certainly produce dark-seeded plants. Therefore extreme care is needed in handpicking. Only the whitest of the white should be retained. If this precaution is taken it is not likely that many coloured plants will appear in the crop. But if the harvest is to be used for seed it is desirable that roguing should be carried out, when the crop is cut, on the lines described above.

Besides being less reliable than the plant-selection method, handpicking is infinitely more tedious. Nevertheless, if one harvest is over (so that there are no standing crops from which to select plants) and one does not wish to wait for the next one before beginning operations, handpicking has its uses. It is a suitable method for getting enough seed to lay down demonstration plots, or for sowing a small field to provide plants for selection at harvest time, by the method already described. The fewer coloured seeds there are in the sample sown, the fewer plants will have to be discarded at harvest time, and the smaller will be the area needed to yield a given quantity of white seed. Handpicking will give an almost pure stand; roguing will complete the job.

PART II.

Maintaining Purity During Multiplication and After.

Either of the methods described above could be used by the average peasant to secure for himself a supply of pure white seed. But both are, to him, somewhat tedious. Furthermore it would take a considerable time to disseminate the required knowledge, even supposing that the cultivator had the energy to apply the knowledge when acquired. On the whole, it is probable that better and quicker results will be obtained by the central multiplication of pure seed, of which an issue will be made to each cultivator, who will then be taught how to maintain the purity, from year to year, of the progeny of that issue.

Given an initial supply of pure seed, there are two main possible sources of contamination: (1) Mechanical admixture of coloured seed due to dirty containers, careless workmen, self-sown seed etc. Adulteration of this kind is common to all seeds, and the remedies are obvious. (2) The segregation of the coloured progeny of heterozygous white seed. It was mentioned above that sesame is normally self-fertilized, but occasional cross-pollination does occur. Therefore, although the vast majority of sesame plants will breed true, there is always the possibility that some of the seed planted for multiplication was out-pollinated, and is therefore heterozygous. The inheritance of colour in sesame seed has not been fully worked out, but it is known that both brown and black are dominant to white. Therefore if a white-seeded plant is fertilized by pollen from a brown or black plant, the resulting white seed, when planted, will produce plants with coloured seed.

It will therefore be necessary to be alert for coloured-seeded plants in the multiplication plot. In large scale multiplication it will be impossible to go through the crop plant by plant, in the manner described for obtaining an initial small stock of seed. We shall have to make the sheaf the unit for roguing purposes. In a small sheaf it is possible to see some of the pods of every plant in the sheaf. When quite dry, the pods split open and expose the seed to view, so that a rapid inspection of each sheaf should reveal the presence of any coloured-seeded plant. It is possible, however, that a small coloured plant might

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Tenure of Native Land in East Africa: The Economic Aspect

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No aspect of rural economy in Africa is of more fundamental importance in relation to the future development of the indigenous races and the economic development of the territories than that of the relation of these peoples to the land they occupy. The present stage of evolution, both of culture and of land tenure is one at which the formulation of sound principles of land tenure is especially vital. Agricultural communities in the territory are in the early stages of evolution from a subsistence to a market economy; from ignorance to knowlege; from wastage of population due to war and disease to the increase which comes between the removal of limiting factors and the voluntary restraint characteristic of a highly developed stage of civilization. The acquisition of material wealth is taking a larger place in the mental outlook of the African and the means of production are beginning to acquire an exchange value. In a primitive system land is the most important element of production and in certain areas pressure of population has already given land an exchange value. The perception of possible future increases in its value will intensify the problem thereby created. The change in rural life and organization is proceeding at such a pace that it might appropriately be called a revolution.

For the sake of clarity in the following discussion systems of land tenure may be classified thus:—

I.—Public Ownership—
- (*a*) Communal Tenure.
- (*b*) Feudal Tenure.
- (*c*) "Cultivating Tenure".

II.—Private Ownership—
- (*a*) Share Tenancy.
- (*b*) Cash Tenancy.
- (*c*) Owner Occupation.

Communal tenure arises in the beginning of agricultural development, when land is abundant and, like fresh air, has no exchange value. Land rights are entirely undemarcated, though the individual will generally be left to enjoy rights of user over the land he has cultivated. Sometimes communal tenure is regulated by local custom in some or all respects, but in other cases the individual is free to follow his own devices. The system persists in relation to grazing land within tribal boundaries in East Africa, and in this sphere there appears to be little development of customary regulation.

Feudal tenure arises where control is vested in a chief or ruler, and it may take any form in other respects. The ruler may have the right of disposal of the land, of re-possession, and of exaction of rent, tithes or labour services. In practice his rights are generally restricted by local custom which may have practically the force of law. The actual means whereby the ruler exercises his rights may at times resemble cash or share tenancy, and at others a communal system. The ruler differs from a landowner in that he is, in theory at least, responsible to his tenants as his subjects; and in that his claims in respect of the land are determined rather by custom than by contract.

The term "cultivating tenure" is used for want of a better to denote the system

whereby the ownership of the land is vested in the Government of a state under democratic control. It is the modern bureaucratic equivalent of feudal tenure and amounts to a system of cash tenancy with the State as landlord. It avoids the pitfalls of private ownership and is designed to secure to the State the incremental value due to improvements by the community at large while leaving to the tenant that portion due to his own exertions and conferring on him security of tenure.

Share tenancy takes different forms in different areas. Generally speaking the landlord provides the permanent equipment and sometimes the stock and implements, receiving half or some other proportion of the produce. In parts of Europe the system has been in existence for centuries and meets the case of holdings like vine-growing holdings, where heavy long-term investments in planting and hillside terracing must be made. In the United States the system has proved of advantage in providing a low rung on the "agricultural ladder" for those with little capital, and leaving some control in the hands of retiring landowner-farmers. In the Argentine it confers on the "colonist" somewhat of the status of a peasant and enables the cultivation of large estates to be carried on with a reduced amount of supervision. In South Africa share tenants are known by "by-woners"; here the system is often adversely criticized, though there seems no reason why, under a proper system of regulation, it should not be successful.

The term "tribal tenure" is best avoided in connection with native lands in East Africa. These are held under a variety of systems which approach here communal tenure, here feudal tenure, there cash tenancy and elsewhere owner-occupation. Generally speaking ownership is restricted by mutual freedoms and obligations of various classes within a tribal unit in regard to occupation and development, and by final control vested in the leaders of the tribal unit, be it tribe, clan or narrower sub-division. The claim of the individual to land rests generally upon right of user, and any rights so acquired are understood to be without prejudice to the equal rights of other members. Rights in respect of arable and of grazing land are acquired independently.

A simple form is illustrated in North Kavirondo where "The land . . . has been acquired by the tribe as a homogeneous unit . . . and all disputed or even debatable questions relating to the land . . . were, according to custom, decided by the tribal elders sitting in conclave under their chosen chiefs . . . While the tribe as a whole is the proprietary unit in respect of the whole area of land contained within the tribal boundary, the native customary unit of land administration is the *lugongo*. This word means a ridge or back and is used because ridges and valleys are the natural features of the country, and the usual clan holding is a ridge or part of a ridge. Each *lugongo* is under the patriarchal rule of an elder . . . whose function is to keep the peace, to protect the land and its occupants and to settle any disputes that may arise. In all matters of moment he consults with the elders of all families resident on the *lugongo* . . . Within the *lugongo* boundaries are the holdings of the various families . . . Each family has exclusive rights of occupation and usufruct over its own holding and these rights pass by inalienable right from father to son . . . There is no conception . . . of individual as apart from family ownership . . . No one can hold land apart from his family,

and no one can hold land otherwise than under the tribal authority . . . In addition to the land over which occupation rights are vested in specific families there is in all areas another class of land specifically set aside for grazing . . . The right of depasturing live stock is common to the tribe on all the land of the tribe which is not under cultivation . . . There is no such thing as the outright sale of cultivation rights as no man can so dispose of his interest in the land which he has inherited from his father as to impair the equal right of his heirs to inherit it from him." (1)

A system broadly similar in its essential basis, though in a more highly developed form exists over the greater part of the Kikuyu Province of Kenya. "The origin of the unit of land tenure in Kikuyu is an original use of an area of bush land, generally by first hunting but sometimes by first clearing, and a continuous tradition of use extending to the present day. This unit is called a *githaka*. The clan recognizes as its first duty the preservation of the land for the use of its members and where tribal theory is intact, refuses to recognize sale, and even the barter of usufruct with right of redemption is only permissible by consent of the elders. An individual sub-owner on a *githaka* is restricted from full ownership, firstly by the privileges which other members of the clan or *mbari* enjoy on the land and which are secured by the customary sanctions of tribalism which tend to prevent individual shares from being precisely defined. In addition to the individual share to which his right is virtually exclusive he has part interest in the reserve areas of uncultivated land which remain undistributed . . ." ". . . Within a *githaka* only cultivated land (fallow and otherwise) is subject to individual inheritance but each adult male member of the *mbari* on his maturity acquires an *ipso facto* share in the undistributed part of the *githaka* (if such exists) whereby he can claim the right to have a portion of it allotted to him in the usual way for cultivation. The eldest son of each widow inherits the control of those areas which were cultivated by his mother and sub-divides these among himself and his younger full brothers."

As the Kikuyu Land Tenure Committee observed "Usufruct and seigniory are the warp and woof of the . . . system. As principles they are in some degree opposites in intention and effect, for usufruct is a personal thing, and as the conception of the uses of land extend and population grows in density it tends to develop into private ownership, while seigniory is a pillar of tribalism and tends to restrict the rights of the individual for the general benefit of the clan . . ."

The economic development of native areas, coupled with the introduction of European conceptions of land tenure is causing a disintegration of the existing land system. Usufruct and seigniory "are opposites which have come together into an equilibrium, which appears capable of indefinite continuance in the atmosphere of tribalism which is congenial to it, but which reveals its instability when new factors are introduced." Out of the break-down the system which seems to be emerging is unrestricted owner-occupation. In Kiambu "the tribal theory . . . has been modified greatly in favour of the individual owner-cultivator . . . If the present tendencies were to continue unchecked for another generation it may be conjectured that in this area the *githaka* would have given place by that time to the small holding as the unit of land tenure."

(2) The evidence before the Kenya Land Commission includes particulars of purchases and sales which appear to point to a conception of full individual ownership in other parts of the Central Province. (3) At a recent meeting at which several Local Native Councils in the Central Province of Kenya were represented, a resolution was passed urging that land which had been purchased under the old redeemable system for a payment of ten goats or more should be made unredeemable. In West Africa Lugard notes that "side by side with . . . primitive conceptions of land tenure we find a growing recognition of the conception of individual ownership . . . In the larger cities of the Coast the conception of individual ownership in land, with the right to sell, mortgage and bequeath it, has . . . become fully recognized, while in the interior the idea has become more and more prevalent." (4)

In this the African will be following almost all old-established communities throughout the world. The natural tendency is for land systems to progress from a basis of custom to one of contract. The African rural economy to-day is comparable in several respects with the manorial system which existed throughout Britain and Northern Europe in the Middle Ages. That system, with its sharp restrictions of individual liberty and enterprise, broke down with the spread of a commercial as distinct from a subsistence economy. The breakdown was accompanied by rural disorganization and great hardships to individuals. Numbers of people are divorced from the land and a social problem of the first magnitude was thereby created. The same forces are capable of creating the same problem in Africa to-day.

It may be said at once that land tenure on the Kavirondo or Kikuyu model is unsuited to the modern needs of the population. Native agriculture can make but small progress without some system securing to the cultivator undisturbed possession of a portion of land which he is free to develop in his own way, and the profits of which accrue to himself alone. Rights of co-owners are a definite obstacle to improvement. This applies not only to long-time capital improvements such as drainage, terracing of hillsides, afforestation, planting of permanent crops such as coffee etc., but also to improved methods which bring in an immediate return. An obvious example is afforded by the management of grazing land and live stock. There is little incentive to reduction of numbers of live stock when each owner suffers no individual loss by overstocking; no individual's reduction will avail anything so long as his fellows do not take corresponding action. No alternative profitable use of the land presents itself to the individual. No methods of improvement of the grazing land are likely to be undertaken, no extension of the practice of growing arable forage crops for cattle nor of saving hay against seasons of drought. Disease control under a system of common grazing is a formidable problem and improved stock breeding an impossibility. Communal elements in land tenure restrict the flow of population from congested to undeveloped areas.

It is evident that these defects are giving rise to a trend towards occupying ownership. Is it clear that this is the best alternative to the older systems? In favour of occupying ownership it is held, firstly, that it promises a stable and contented rural population and a bulwark against subversive elements. The man of property is always interested in the maintenance of a strong government.

It is generally held that occupying ownership conduces to intensive cultivation of the soil. "The magic of property turns sand into gold" wrote Arthur Young in describing the minute labour and unremitting zeal bestowed by European peasants on their small patrimonies. Of one of the places reached in his travels he writes "An activity has been here that has swept away all difficulties before it and has clothed the very rocks with verdure. It would be a disgrace to common sense to ask the cause; the enjoyment of property must have done it. Give a man the secure possession of a bleak rock and he will turn it into a garden; give him a nine years' lease of a garden and he will convert it into a desert."

It is undeniable that occupying ownership tends to induce improvement of property, as compared with any form of tenancy, though perhaps Arthur Young underrated the effect of pressure of population on the land and the cult of "the poor man's savings bank". How far the effect is due to actual ownership and how far to security of tenure must be left to conjecture.

In the meantime, no obstruction appears to be offered to the spread of occupying ownership in Africa. In some continental countries the superiority of the system is regarded as exiomatic and one may expect a verdict such as that expressed in the French Colonial Budget Report of 1910 (quoted by Lugard) "the system of individual ownership is incontestably the one which is most favourable to production." In the Belgian Congo it appears to be expected that the ultimate desideratum is the liberation of land titles so that they can be used as security for loans. The committee on Kikuyu Land Tenure maintained a non-commital attitude on the subject, but one member devised a set of rules to govern the small holding, claiming for them that "they attempt to face the basic problem, which is how the owner-occupier can develop his plot in security." A passage in the Kenya Native Affairs Department Report for 1934 states that the conversion of family or clan lands into individual holdings "must win the friendly support of Government." In Uganda steps have been taken to meet the tendency towards rack-renting on the part of landlords by granting freeholds where this could be done, and "great activity in respect of transfer of land has been displayed by natives whose great aim is to acquire small holdings and thus free themselves from the exaction of the landlords."

On the other side it can be demonstrated that peasant proprietorship if allowed to develop uncontrolled, is fraught with the gravest dangers. The chief of these are:—

(*a*) Over-capitalization and indebtedness of occupying owners.
(*b*) Excessive sub-division of holdings.
(*c*) Fragmentation of holdings.
(*d*) Eventual appearance of a parasitic landlord class.

(*a*) One of the first effects of the creation of negotiable titles in land is the increase of value which occurs in the free market which arises. At the best, this is a deterrent to development, preventing those with insufficient capital from acquiring land and often tempting cultivators to sink too large a proportion of their capital in land purchase, leaving insufficient working capital. It provides opportunities for owners whose land has appreciated in value to take their accrued profits and withdraw their capital from the industry.

It will not have escaped notice that the native's great strength to-day is his

freedom from "overheads", and that his position compares very favourably with that of producers under more highly capitalized systems. Freedom from overheads, while in some cases necessitating a slower tempo of development, offsets this disadvantage with an immense gain in social stability.

At the worst, occupying ownership opens the door to a disastrous accumulation of debt. Such a state of affairs can be observed to-day in almost every community in which the system is general. It should be observed that the phenomenon is not peculiar to the present depression. As early as 1906 Nicholson wrote of Denmark, "Nominally the peasant proprietors are freeholders, but they are saddled with a mortgage debt of £60,000,000, which represents 55 per cent of the value of their farms, with buildings, stock and improvements. In every age and in every country the mortgage has been the curse of the peasant holder." Even further back, in 1893, an observer in the Argentine wrote of the period following the Federation: "as is not infrequently the case the inhabitants became intoxicated with the brilliant prospects of the country and speculation took the place of thrifty labour . . . and of course one day the bubble burst." Farmers have always shown a disposition to capitalize their business up to the limit of contemporary values of produce and even to anticipate subsequent rises. The agricultural price level has never been and probably never can be stable. In consequence farms have generally become capitalized at the peak of the waves, and the subsequent falls have undermined their economic foundations. It is in waves of prosperity that land transfer is most active, thus providing the maximum opportunity for values to follow rises in the price level.

Instances can be adduced from almost every country in the world. A New Zealand economist writes of "land speculation induced by rising prices . . . During the upward drift of prices from 1895 . . . the more favourable position of the farming community gave rise to a greatly increased volume of speculation in land values. The gains from rising prices were heavily discounted in advance and the values of land rose more steeply than the prices of the produce to be taken from the land. The paradoxical position was thereby created that at any particular moment the economic position of the farmers was unstable and unsound, while the upward sweep of the price level kept on salving those farmers who had bought at higher than productive values. In doing so it provided the occasion to repeat the instability at higher values, and so the process went on until the check to the price level in 1921 brought drastic readjustment." (5)

An American agricultural economist writing in 1925 corroborated this view in the words: "Nature has been good to the New Zealand dairymen . . . but these advantages are neutralized in the speculative bidding of excessive prices for dairy land . . . one is amazed at the overhead load of interest or rent which is voluntarily assumed . . . since the war the bubble has burst. The man who bought during the boom is broke . . . New Zealand dairymen largely capitalize the natural advantages of their land . . . into a fixed investment upon which it is difficult to realize an adequate income except by the sale of the farm." (6)

This state of affairs can be parallelled in the United States, Argentine, South Africa, Southern Rhodesia, Kenya and many other areas. When peoples in an advanced stage of civilization arrive in

their present predicament little can be expected from more primitive communities. In India "the total sum advanced (upon land mortgage) . . . most represent a very large sum locked away . . . When it is remembered that this type of security did not exist to any extent before the introduction of the British legal system it becomes possible to realize how rapidly it followed on the settlement of rights in land and the rise in land values which resulted." (7) Of the loans advanced by co-operative credit societies, in 1932, 78 per cent of the amount due for repayment was in arrears and the arrears of payment were keeping pace with the larger amount of loans being granted.

In South Africa, "where natives have held their land on a title whtich could be pledged as security for loans, they have in a very large percentage of cases lost the ground altogether". "The individual native can only in exceptional circumstances be trusted with the borrowing of money. The great fear is that such money will not be used for productive purposes, but will soon be wasted, leaving the borrower in a worse position." (8)

In the smaller islands of the West Indies "a peasantry has tended to develop . . . particularly in Barbados . . . The development . . . commenced towards the end of last century and was accelerated during and since the war. Prices of land of £100 to £125 became reasonably common . . . The economic effect of this development is disastrous." (9)

In Egypt "perhaps the most important problem has been agricultural indebtedness . . . The enormous fall (in prices) seriously increased the real burden of their debts . . . It is not only the question of a moderate amount of working capital, which can often be repaid after harvest. There is a large and important class of debtors who have been obliged to find substantial capital either for the purchase of their land or for its development and improvement by means of loans repaid by annuities spread over a number of years. The majority of such loans were incurred at a time of much higher prices than to-day; the regular payment of the annuities is now difficult if not impossible. There has been a danger of expropriations on a large scale, with serious economic and social consequences." (10)

Over-indebtedness results in the destruction of necessary working capital and thus diminishes the debtor's economic efficiency. In many cases dispossession results, with harmful economic and social effects. In the less advanced countries mortgage credit "is too often an indication that a weak debtor has fallen into the hands of a strong creditor. The mortgagor too often declines to the position of a permanent tenant under the mortgagee, paying not a fair rent, but the utmost the lender can extract or extort". The mortgagor in such a situation, like the Irish tenants under the old rack-renting landlords, becomes content to produce a mere subsistence in the certainty that the cash returns from any surplus will accrue merely to his creditors.

If present tendencies are allowed to proceed unguided it is inevitable that the evils which have arisen in other parts of the world will arise also in native areas in East Africa and it may be conjectured that this area would prove a prolific seedbed for undesirable growths. The African is as improvident and as rapacious as the Asiatic, and there are not wanting both Africans and Asiatics who would be prepared to finance cultivators at a profit-

able rate of interest, immediately legal titles to land were established. The foregoing examples show that growth of indebtedness among peasant owners of land is not due to exceptional circumstances such as the war and the present depression, but is a weakness inherent in the system. The cause is a basic trait in human nature.

(*b*) In an increasing population there are two evil alternative methods of succession to property:—

(i) To restrict succession of the land to one heir, leaving movable property to others.

(ii) To divide the land equally amongst all the heirs.

In the first method, if there is sufficient movable property to provide a fair share to the others all is well unless at the same time there is none remaining to provide the landed successor with necessary working capital. More often there is insufficient even for the former purpose. In either case the outcome probably is the pledging of the property, in the one case to provide the new proprietor with working capital, in the other case to pay out the other heirs. Even where capital requirements for agriculture are very small it would probably be no long time before a formidable wall of debt had arisen.

In the second method the property becomes cut up in course of time into holdings of uneconomic size. Its effects are well seen in parts of the continent of Europe. In France, under the working of the Code Napoléon which prescribed equal division of property among children, it was stated in 1868 that "of our five millions of small rural proprietors three millions possess on the average but a hectare apiece (2½ acres)." "A majority of the properties are so small as not to afford a subsistence to the proprietors." In Switzerland "the subdivision appears to be often so minute that it can hardly be supposed not to be excessive, and the indebtedness borders on the incredible, so that only the intensest industry, frugality, temperance and complete freedom from commerce enable them to stand their ground." In Switzerland to-day 42 per cent of holdings are less than 7½ acres in extent. This is in spite of a restraint on increase of population which is attributed to peasants who foresee the unwelcome effects of sub-division upon the lives of their successors, a restraint which has kept the population of whole districts in France stationary for half a century. In Germany in 1925, 59 per cent of holdings were under 5 acres in extent.

In Denmark "the maintenance without undue sub-division is brought about partly by the deeply-rooted sentiment of the whole peasant population . . . The Danes cling to the thought of the farm as a unit which ought to pass without diminution to one of the sons, the rest being compensated by the new recipient." Also, Government takes a hand in preventing undue sub-division. In consequence only 19 per cent of Danish farms are under 8¼ acres, and only 7 per cent under 4¼ acres. Mortgage encumbrance is mitigated by the practice of valuing estates on death of the owner at below the market price, the co-heirs being thus forced to contribute to the establishment of the one who succeeds to the property. In Germany legislation has recently been passed restricting the powers of owners to sub-divide their property.

In the coastal area of Kenya, the only part in which land is held by Africans on private title, the evil of sub-division has appeared in an exaggerated form. "Plots of about 3 acres are sometimes

held by as many as fifteen persons, whose shares are in different proportions according to their position in the Mohammedan scale of inheritance. The problem . . . would appear in Nyeri and Fort Hall districts also, if the restriction against sale were removed." "In Kiambu . . . sub-division is in full swing." (11)

In Barbados the consequence of peasant proprietorship has been that "of the 18,000 holdings is the island, no less than 77 per cent are under one and 95 per cent under three acres. Skeete . . . expresses the opinion that in normal times an unencumbered plot of 5 acres of good land is the minimum economic area for a contented peasant." (12)

(*c*) Closely allied to the question of sub-division of holdings is that of fragmentation, which is the acquisition of small units of land scattered in various parts. The fragmentation may occur with units of land owned by an individual or may take the more serious form of fragmentation of units of cultivation. In India "Fragmentation among right-holders' holdings is chiefly due not to the laws of inheritance but to the method by which the law as to division of property is carried into effect . . . The custom of dividing property among heirs is to give to each heir a proportionate share of each item of the inherited property and not a share of the whole equivalent to this portion . . . Each plot must be divided . . . Successive generations descending from a common ancestor inherit not only smaller and smaller shares of the land (sub-division) but inherit that land broken up into smaller and smaller plots." (13)

There appears to be a precedent in Kenya for this procedure. The Kikuyu Land Tenure Committee reported that "when a piece of land had been acquired by purchase it became the absolute property of the purchaser and on his death had to be divided among his sons. In the distribution they were not necessarily given land in a single block but rather in such a way that each might have a share of the various classes of land available."

Fragmentation arises also from piecemeal purchase and sale of small parcels of land and by irregular invasion of the unoccupied waste. The extent to which it can go on is seen from the case of a village in the Punjab in which there were five owners with over one hundred plots each.

The introduction of efficient methods of cultivation becomes circumscribed by the small size of the individual parcels, and much waste of land takes place by provision of boundaries and in other ways. "In the Punjab the results of consolidation indicate that 5 per cent of the land which would normally be cultivated is lying useless owing to fragmentation being so excessive as to prevent any agricultural operations. A further 1 per cent is lost in boundaries." There is considerable loss of time and labour in walking to and from scattered plots and in gathering in the produce. The keeping of live stock is difficult unless common grazing is available. Improvement of cultivation is checked and uniformity of cropping encouraged. Though there is a certain advantage, where the soil is very variable, of providing that each holding includes a portion of the different types of land, in most cases it can truly be said that fragmentation is "an unmitigated evil for which no advantages can be claimed."

(*d*) Where tenancy is successful it is so chiefly by reason of a benevolent and enlightened attitude on the part of the landlord. In Britain the landlord-and-tenant system has been successful because

of a tradition of fair dealing which has been maintained among the hereditary landlords. Yet even there it has been deemed necessary to introduce successive legislative measures which have deprived the landlord of almost all control over his property.

In Uganda steps have already been rendered advisable to deal with a situation in which a tenancy system of long standing has become a danger with the introduction of commercial agriculture. The tenants under the Butaka system could be evicted at pleasure. The system "is productive of numerous abuses, . . . Landowners tend to degenerate into mere rent farmers, . . . Rack-renting has become a possibility of which account must be taken." Legislation has already been enacted to limit the powers of landowners as to the rent to be charged and securing the tenant from eviction except for good and sufficient reason.

Tenancy is a natural consequence of indebtedness. Land becomes an object of speculation, to the danger of those in occupation, who in the absence of protective legislation may have their land and homes sold over their heads at a price which includes any improvements they have themselves made.

Though the tribal systems of tenure are inimical to progress, the facts which have been adduced in the foregoing paragraphs indicate the potential dangers of allowing evolution to follow its own course. The further evolution is allowed to proceed, the greater the importance of the vested interests created, and the more difficult it becomes to direct the course of evolution along any desired channels. To wait until unfortunate consequences arise and then to attempt to remove them by piecemeal legislation may create as many new problems as it solves.

The question of what action should be taken resolves itself into two components, principle and application.

In principle it will probably be agreed that it is desirable to avoid as far as practicable the four developments which have been discussed above. It is not improbable, however, that countervailing factors may make it impossible or undesirable to do so entirely. An increase of population must be envisaged, with, in some areas, an intense pressure of population on the land. In order to mitigate regional pressure, it will become necessary to facilitate rural migration. This could be done most easily by the creation of a land market, but there are other and less dangerous methods of reaching the same goal. So far as it should be impossible to prevent pressure on the land, it may be difficult to find an alternative to excessive sub-division of holdings. Intact holdings held jointly by more than one person might or might not be preferable to uneconomic subdivision. Both have disadvantages, but a choice must be made between them when a certain density of population is reached, unless the surplus population can find other means of support. The problem here impinges on the development of native trading, domestic manufacturing and other forms of secondary industry, and of the outside labour market.

The worst dangers, those of indebtedness and the consequent development of a parasitic landlord class, might be averted by the simple process of making hypothecation of the land and of cultivation rights invalid in law. Failing more comprehensive measures this would be a valuable safeguard.

Another method of achieving the same result would be to adopt the Nigerian system, in which lands declared as native lands are placed under the disposition of the Governor for the benefit of the natives. Titles may be granted, but the single form of title is an inalienable one of occupancy for a definite or indefinite period, for which a revisable rent is charged. Devolution on death of a native occupier is adjusted by native custom, subject only to sub-division requiring the consent of the Governor. The system is similar to that which was advocated under the term "cultivating tenure" by the Liberal Land Committee. Under this scheme the cultivator becomes entitled to undisturbed possession of the land in his occupation, except in circumstances when it is in the public interest to remove him, such as in the case of his allowing the holding to deteriorate. He is entitled to the full value of all his improvements in the land. The land itself, however, never becomes his personal property. It remains the property of the State and as such cannot be offered as security for any loans. The State, remaining in effect the landlord, can control the sub-division of holdings and to a large degree their layout. It remains in possession of a direct interest in land improvement, provision of transport facilities, etc. The benefit of public works is retained by the community at large and does not go merely to swell the "unearned increment" of landowners.

The system of "cultivating tenure" cannot be adopted where vested interests have been created on a large scale; the difficulties have by that time become practically insuperable. It can only be adopted where little capital has been invested in the land and private rights are little developed. Where these conditions obtain the system offers advantages which go a long way beyond those offered by the mere restriction of alienation and hypothecation. If offers the fourfold advantage of the continuance of tutelary power by the State, of providing security of tenure to occupants, of leaving the way open for those improvements in the land system which must inevitably accompany the general progress of native development, and at the same time of avoiding the pitfalls which await uncontrolled evolution. It offers a means of retaining within the field of tribal control individuals who, as free landowners, would drift outside its sphere of influence. The system admits of elasticity in operation and of development *pari passu* with native development in its broader aspects. It admits of the possibility of association of properly constituted native authorities with the tutelary power of the Government, and through them of the dissemination of education and propaganda on land questions.

As regards practical action, it will be necessary to have regard to the circumstances of individual areas. In some areas evolution has proceeded so far that relatively little can now be done. In others there is much scope for action, but a fear that any action will result in a state of high political tension.

The various difficulties need not give rise to a view that nothing whatever can be done. Systems of land tenure are being gradually modified even in areas where they have been established in broad outline for a long period. Once a definite aim is set gentle pressure can be continuously exerted in the required direction.

The remainder is a matter of administration and not of economics. It may be that indirect rule is an indispensable con-

dition of interference with the course of evolution. If so, are there in existence native authorities suitable for the purpose, or would it be necessary to constitute new bodies drawn from the land-owning classes? If it should be possible to introduce the system of "cultivating tenure" in any area it would be necessary to charge a rent for the land, but Lugard found in West Africa that this was impracticable except by calling it an income tax. Would a land tax be acceptable where the primary land authority was an elected native body, and Government control was kept discreetly in the background; where, in fact, it was made to appear that the natives were running their own show? Where "cultivating tenure" in its pure form cannot be introduced can some of its advantages be secured by a development of co-operative societies of *githaka* owners or persons in a similar position?

It is hoped that these notes may elicit the views of persons with administrative experience. By constituting in the imagination a "second India" on the one hand, and on the other, a "Denmark without debts", it is possible to derive an impression of the tremendous social and agricultural importance of the subject of land tenure at the present stage of rapid transition.

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Feeds for Live Stock.

The maximum use must be made of home-grown feeding stuffs and in this connection the wider cultivation and use of legumes is to be encouraged.

Cheap supplies of local surplus foods and by-products should be fully exploited.

Only the minimum amount of highly concentrated foods should be purchased.

All feeding must be controlled primarily by the cost of the food and the market value of the product.

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The Culture of Granadillas

(*Passiflora Edulis*)

PREPARATION OF JUICE.

Juice is extracted from the fruits by various methods including that of piercing and suction, but should small samples be required, this is done by cutting them in halves, extracting the seeds and juice with a wooden spoon and removal of the seeds by straining through a fine sieve. An article on the recovery of the juice appears elsewhere in this Journal.

The Culture of Granadillas (*Passiflora Edulis*)

Following favourable commercial reports received on samples of granadilla juice sent home to England, numerous inquiries for information as to the culture of granadilla or passion fruit have been received by the Department of Agriculture, Kenya Colony.

This fruit has been grown in the Colony by individuals for their own consumption for many years, but has not been planted on a commercial scale. For this reason information as to the most profitable methods for large scale planting in this country are not available, and at present it is necessary to rely on information obtained from New Zealand and elsewhere.

Variety.

The variety grown for the production of granadilla juice is the common purple-skinned granadilla (*Passiflora edulis*) which has bright orange-coloured pulp.

Altitude and Soil.

This fruit will grow in Kenya at altitudes of up to and over 7,000 feet, but the yield is less at the higher altitudes than at lower ones, also the fruit ripens better at lower elevations. The samples of juice sent to England were prepared from fruits grown at about 6,200 feet near Kitale.

A well drained, friable, rich, sandy, loam is the best type on which to cultivate granadillas. Very heavy soils should not be selected. If there is stagnant water at the roots, the plants are unable to produce profitable yields of fruit.

An aspect with plenty of sunshine is essential. The crop should be protected from very strong winds. Windbreaks should be planted for the purpose.

Propagation.

Granadillas are grown from seeds or cuttings. When seed is used this should be taken from the fully matured fruits of robust plants. At a later stage when these have been selected, it may be possible to take seed from individuals bearing fruits with a high percentage of juice compared with total weight.

In the *Queensland Agricultural Journal* of July, 1931, it is stated: "The pulp when removed from the fruit, should be placed in a tub or suitable vessel and be covered with water, the mass being then allowed to ferment long enough to free the seeds from the pulp, when they should be strained off, well washed and dried. Prior to planting, the seed should be soaked over-night by placing it in the bottom of a basin and pouring hot water, at a temperature of 180 degrees Fahr. over it, and allowing it to remain until the following morning. If early spring-ripened fruit is selected and seed is planted as soon as ready, good strong plants are wanted for early spring planting, but, if plants are wanted for early spring planting, the seed must be sown the previous autumn. The seed should be sown in a specially prepared seed-bed in soil of a light, free nature, containing a quantity of leaf mould or humus—a good potting soil—and the young plants should be sheltered from the sun and judiciously watered should the soil become dry. When the seedlings are about 1 foot high or larger they should be planted out in the permanent position, taking care to keep them moist so that they will not dry out."

In the *Tropical Agriculturist*, January, 1933, the Curator of the Royal Botanic Gardens, Peradeniya, Ceylon, states "The plants can be raised from either

seed or cuttings, the latter being the usual procedure, selecting matured shoots of 8 to 9 inches in length and inserting in a well-prepared bed of sandy soil. If seeds are used these should be selected from well-ripened fruits, but on extraction from the pulp they should not be washed, but mixed with sand and dried. This both separates the seeds and prevents their becoming infected with mildew which otherwise occurs if the seed is washed. Sowing in situ or in nursery beds with later thinning out is recommended by some and in boxes or pans by others, but since the vine objects to too much root disturbance, sowing in nursery beds is generally preferred. The seeds should be sown about ½ inch deep and 1 inch apart, later thinning out to 3 inches apart. The seedling nursery bed plants should be put out in permanent quarters from six to eight months after sowing. A longer period is required if seed be sown in boxes."

TRELLISING AND PRUNING.

The granadilla is a strong climbing vine and requires supports upon which it may be trained. Again quoting the Ceylon authority: " . . . a good stout trellis of 5 to 6 feet in height answers the purpose, the vines being planted 15 feet by 20 feet apart and trained along the wires and supports of the trellis. Grown thus it is necessary that the vine be trained fanwise on the trellis and not allowed to run wild. The trained stem will then form laterals from which the fruit is borne. Regular pruning is necessary as the vine bears fruit only on the new wood and each season the laterals should be cut back to within two to three buds from the main stem to encourage further new wood and crops."

In Queensland, where commercial cultivation of the fruit is practised, a different system is recommended. Prior to planting, the land is marked off in rows not less than 10 feet apart. A trellis of good fencing posts placed 15 feet apart is erected along the row. The posts should be about 8 inches wide by 3 inches thick by 6 feet 6 inches long, and be set 20 inches in the ground. These should be set in the ground with their width across and not in the direction of the row. As they have to act as strainers to prevent sagging of the top wires when carrying a heavy growth of vines, the end posts must be well strutted and be much heavier than the others. Also, they must be sunk much deeper in the ground. Posts impervious to attack by termites should be used, or where this is not possible they should be treated with wood preservative. Two No. 8 galvanized wires are secured firmly to the top of the posts, one on each side, so that when in position they form parallel lines, 8 inches apart, on which the vines are trained. The young plants are planted midway between the posts, immediately under the wires, and are tied to a light stick or other temporary support till they reach the top wires. Having reached this height, they are topped and two main lateral stems are allowed to develop. All other lateral growths on the main stem from the ground to the wire are removed. The two main laterals are trained on to the top wires, and when they meet their growth is stopped by removal of their tips. This causes the growth of further laterals on which fruit is produced. These secondary laterals throw out further shoots, and these in turn make more lateral growth. Thus a very dense and tangled mass of vines is produced from which it is hard to separate the primary and secondary laterals. Dense growth of this nature is conducive to disease. Therefore systematic pruning is desirable

(*a*) to keep the plants healthy, (*b*) to produce strong new lateral growth on which good fruit will be grown, and (*c*) to bring in the crop at different times to prevent gluts of fruit at some periods of the year and scarcity at others. When an autumn or winter crop is desired the main summer crop must be sacrificed. This is done by pruning the vines right back to the secondary laterals when they are showing their blossoms for the summer crop. This has the effect of causing a new growth which will produce flowers at a later date. A word of warning is necessary, however—do not carry out severe pruning in dry weather—it may kill the plants. Wait until rain has fallen and the ground is moist once more and the plants will throw out a fresh growth immediately and will not be permanently injured. A good dressing of quick-acting manure at this time will be found beneficial and considerably increase the subsequent crop. The granadilla plant lives for five or six years, if given proper attention, and should give two crops of fruit annually.

MANURING.

Heavy manuring is advocated. A small quantity of well-rotted boma manure placed in the hole dug for each plant will help to give each a good start. Heavy applications of boma manure given subsequently may be beneficial. Dressings of 100 to 200 lb. of each of rock phosphate or bone meal, sulphate of potash and nitrate of soda or sulphate of ammonia may be given at the commencement of the rains following pruning.

Spaces between trellises can be used to grow catch crops of beans, peas or the New Zealand custom of growing green manure crops such as lupins, and turning them under, might be followed with advantage.

On portions of the land devoted to the crop in Kenya it may be advisable to test the effect of lime by applying it at the rate of 2 tons per acre. In Ceylon a good dressing given to the soil before planting is recommended.

RETURNS.

It is probable that yields equal to those in any other part of the world can be obtained in this Colony but it is not possible to give accurate figures until the crop has been tried more extensively in Kenya. According to particulars given in brochures of companies interested in the development of the passion fruit industry in New Zealand—which should perhaps be regarded with caution—400 vines gave 9,600 lb. of fruit per acre during the second year. The average yield of fruit on established plantations in New Zealand is said to be about 16,800 lb. Forty to fifty lb. of fruit are needed to give a gallon of juice. From these figures the yield of juice would be 190 to 240 gallons per acre from a second-year crop and 340 to 420 gallons from an average crop from an established plantation. It appears that about Sh. 5 a gallon may be anticipated in London.

PESTS AND DISEASES.

In Ceylon, leaf-eating caterpillars and sucking bugs are troublesome occasionally. These can be checked by periodical use of paris green or arsenate of lead applied in the form of very fine sprays.

HARVESTING OF THE CROP.

In the fully ripe state, fruits have a characteristic wrinkled appearance. It is most important that all fruits should be fully ripe before being used for extraction of juice. If unripe, overripe or fermented fruits are used, the quality of the bulk of juice will be reduced.

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Pigs for Bacon Production

By M. H. FRENCH, M.A., *Dip. Agric.* (*Cantab.*) and H. E. EMSON.

INTRODUCTION.

Pigs are becoming of increasing importance yearly because of the steady demand for pig products and the ability of the pig to thrive under very diverse conditions of climate and management. Experience has proved that pigs can be reared very successfully in East Africa, and particularly in the highland areas.

Pig farming can offer prospects just as remunerative and attractive as any other branch of animal husbandry in East Africa. The breeding and rearing of pigs involves very little trouble on the part of the owner, because the pig is subject to comparatively few ailments and diseases compared with other domestic animals. In addition, provided adequate feeding is given, the rate of increase is very rapid. The first litter can be produced at just over a year and two litters in each subsequent year. Each litter will average between eight and ten pigs, so that the pig population can be increased at a very high rate.

The rate of growth is greater than for any other farm animal. A pig can be born, reared and sold for bacon all in six months. On account of this prolific and early maturing nature, pigs need to be subject to organized marketing and curing schemes. The closest co-operation must therefore exist between the pig breeders and the bacon curing factories. Each farmer should breed only that number of pigs which the factory has guaranteed to take. With an animal so prolific as the pig, it is absolutely necessary to breed only a limited number of good animals. The pig population can increase so rapidly, with a consequent fall in market prices, that pig breeding, unless controlled, can quickly reach an uneconomic state. Provided, however, that each farmer aims at breeding only that number of pigs which the factory can guarantee to take, then the market price will remain fairly constant.

The pig is becoming increasingly popular as an animal suited to the small holder. The capital involved is not large, and the turnover is very rapid. Owing to its omnivorous appetite the pig will fit into so many small holders' undertakings. A pig can convert many waste products into cash crops, and provide the means for many other crops to be marketed when otherwise they would be a drug on the market. For example, waste dairy products (skim milk, whey, etc.), maize, tail wheat, potatoes, etc., are made use of in many parts of the world as pig foods when the market price of such commodities is small compared with their value in the form of pig meat.

Besides being omnivorous, the pig is a very economical converter of food into flesh—probably more so than any other farm animal. Though a pig needs to live well, he dies well, and in this connection he yields a higher percentage of carcase to live weight than do other meat-producing animals.

THE TYPE OF PIG TO BREED IN EAST AFRICA.

In East Africa, it is only in the large towns that the demand for pork will justify the breeding of pork-producing pigs. For the majority of farmers however, pig breeding will mean the production of a bacon type of pig, since bacon is the form in which most pig products can be transported in the tropics. Naturally there is a demand for pork sausages, but normally these will be

produced by the bacon factory from pigs which do not come up to the required standards for bacon production. In this article therefore, we feel justified in dealing with the bacon pig only. It is absolutely necessary to study the consumer's requirements before attempting to produce the article required. In East Africa the consumer requires the assurance that pig meat will be wholesome and edible. In most districts this can only be achieved by curing the pigs into bacon because fresh pork would not keep sufficiently wholesome in the heat.

Bacon Type of Pig.—The object in breeding pigs for any purpose is to get the right proportional distribution of bone, muscle and fat in the animal to suit the palate of the consumer. This is attained in the bacon pig when the live weight reaches approximately 200 lb. Not only the live weight, but the general conformation, and the breed of pig affect considerably the quality of the meat.

Generally we may take it however that the ideal bacon pig is a pig of good length, fair depth and thickness and evenly covered with firm flesh, weighing from 160 lb. to 200 lb. live weight. The head should be fairly long, clean cut and free from excessive flesh, the neck should be of medium thickness. It is essential that the shoulders should be light and nicely rounded to the body, whilst the hams should be full and well formed, tapering down to the hocks.

The back should be slightly arched from neck to tail and should not be too wide; generally speaking a pig with a wide back carries too much fat for bacon purposes. The tail should be placed well up on the hinderquarters and the animal should show "breeding", i.e. fine hair and skin, trim appearance and not too much bone.

Breeds.—The most suitable breeds for bacon purposes which are available in East Africa are the Large White, Middle White, Large Black and Deutsches Edelschwein. None of the last three breeds are considered ideal bacon pigs when purebred, but particularly the Deutsches Edelschwein which is too heavy in the shoulder and which carries a very high percentage of fat to lean. All make good baconers when crossed with the Large White and fed on proper bacon-producing rations. It should be particularly understood that the correct cross in every case should be the Large White boar on whatever breed of sow it is intended to use.

White breeds of pigs are more liable to suffer from sun scald in the tropics than are black breeds, but they are definitely superior to the black breeds for bacon production. The females of black breeds suffer from a defect known to bacon curers as "seedy cut" or "seedy belly". This is due to the black pigmentation of the skin appearing in the mammary glands and causing black spots to appear in the belly portion of the bacon.

The cross between the Large White boar and the Large Black sow produces a blue and white pig which is not so likely to possess this "seedy cut" defect as pigs of black breeds. This cross is quite suitable for bacon production and suffers but little from sun scald.

Successful Bacon Production.—The secret of success in breeding good bacon pigs is uniform breeding and feeding. Much of the success of the Danish pig industry is due to uniformity in the breeding and feeding of the pigs. Neither a badly bred pig well fed, nor a well-bred pig badly fed are capable of yielding first-class bacon, the two things must go hand in hand.

There is a third factor in successful bacon production in addition to the

above two, namely, the pigs must be well cured and graded according to quality, if they are to be marketed properly and meet the demands of the consumers.

Therefore to get good bacon we must breed well, feed well and cure well.

THE MANAGEMENT OF BREEDING STOCK.

Boar.—It may be taken as a general rule that the boar should not be allowed to serve a sow until he is eight months old, and even then the number he should be allowed to serve should be restricted to two a week. Four to five sows a week should be the maximum allowed when the boar has reached eighteen months of age. The feeding of the boar should be very carefully regulated. He must be kept in good condition and be active, and not carry too much fat. Over-fattening makes the boar too heavy for the younger sows, and often predisposes to sterility. It is a good practice to allow the boar to be turned out into a paddock or yard. He then gets sufficient exercise to prevent over-fattening taking place, and the boar will remain in good hard condition.

Normally the boar should not be used after he is three years old because old boars are often too heavy for the young sows, they require a large amount of food, and are often responsible for small litters. Of course if a boar has proved himself an exceptionally good stock getter, use should be made of him on good sows for as long as possible. The rate of reproduction is so high in the pig that no difficulty is to be anticipated in replacing the stud boar quite frequently.

Where a large number of sows are kept it is better for the boar to be kept apart, and for the sows to be brought to him for service when they come on heat. When only a few sows are kept the boar may be allowed to run with them.

The Sow.—Much care should be exercised in choosing a sow for breeding purposes. Besides being a typical specimen of her breed, she should be good tempered, long and roomy and possess at least twelve good teats well spaced on her udder. A well-grown sow is ready for service when she is eight to nine months old, which means that she will farrow her first litter when just over a year old.

Delay in serving a sow is uneconomical, because she is simply costing money to keep when she might be producing a litter. Too early service is to be avoided otherwise her development will be retarded, and she will produce weak offspring.

The number of piglings the sow should be allowed to rear of her first litter should be restricted to a maximum of eight. If more than eight piglings are reared the sow often draws upon her own skeleton and tissues to maintain her milk yield, and as a result may suffer seriously.

It is a common practice to send all the pigs from a first litter to the butcher and to select pigs for breeding purposes only from the later litters.

In the second and subsequent litters one should aim at the sow rearing an average of ten pigs, but never more than twelve at one time. When more pigs are born than it is intended to rear, the weaklings should be killed off after a day or two.

After producing her first litter it is advisable to give the young sow a rest before she is served for a second litter. The best time to serve her will be about two months after her first litter is

weaned. In the case of mature sows however, no such rest period is necessary and they should be served at the first heat period after farrowing. This normally occurs six to eight weeks after farrowing so that litters are born at approximately six-month intervals.

The period of gestation in a sow is 112-120 days. Oestrum lasts from two to four days and occurs at intervals of twenty to twenty-one days if mating does not take place.

Breeding sows should not be too fat because this tends towards sterility or the production of undersized offspring. Like the boar, they should be allowed to exercise in a paddock or yard. In the tropics it is very necessary that these runs should be provided with thatched shelters if there are no trees to provide shade. Regular feeding supplemented with a mineral lick is to be advocated and an adequate supply of fresh water should be provided.

Sows of four years old or more are not economic propositions. They become heavy and clumsy with age so that the casualties amongst their offspring become greater. With age they also become less prolific and consume much more food than a younger and smaller animal.

In-pig Sows.—About ten days before farrowing the sow should be brought in from the paddock to the farrowing pen. This pen must be warm and dry, and a run must be attached. The pen should be fitted with a farrowing guard, this consists of a rail running round the pen about nine inches from the floor and about the same distance from the walls. The object of this guard is to prevent the sow from crushing her young against the walls when she lies down. Bedding in the farrowing pen should be scanty and consist of short dried grass or chopped straw. The young pigs are then able to move about freely and are less likely to be smothered. Normally the sow has little trouble farrowing but it is wise to keep an eye upon her whilst this is actually taking place.

The Sow with Young.—As soon as the young pigs are born they should be dried. The after-birth should be removed from the pen as soon as it is dropped. If this is not done the sow will often eat the after-birth, particularly if she is suffering from shortage of protein and minerals. It happens occasionally that in spite of good protein feeding and with a mineral supplement, that certain sows have a perverted appetite and will eat the after-birth as soon as it comes away, such sows invariably eat some or all of their young. This habit in well-fed sows is impossible to overcome and the sow should be destroyed.

All weaklings or "runts" should be killed as it rarely pays to rear them. When about three weeks old the young pigs begin to take interest in the food given to their mothers. It is at this time that they should be taught to eat from a trough. Such a trough should be placed so that the young pigs have access to it but so that the sow cannot get at it. A good way of achieving this is to rail off a corner of the run, so that the trough can be placed in the corner, and so that the gaps between the rails are large enough for the young pigs to pass through but not wide enough to let the sow through.

Plenty of space should be provided at the trough for all the young pigs to feed. Success in feeding young pigs depends upon two factors, (1) Feeding only good wholesome food, and (2) Feed a little at a time but do this often.

During our visits to pig farms in East Africa, we have been struck by the large

number of wooden "dug-out" troughs that are in use. This kind of trough is absolutely unsuitable for feeding young pigs. Liquid foods soak into the wood and ferment there because it is well-nigh impossible to clean such troughs efficiently. Fresh food poured into such troughs rapidly becomes sour.

Where permanent pig houses have been constructed, good feeding troughs can be made with concrete. Such troughs should be provided with a plug and outlet, so that they can be easily washed out. Where movable troughs are required these are best made by nailing galvanized iron sheets on to wooden frames.

At six weeks old all male pigs not required for breeding purposes should be castrated. From the day prior to castration to the day after castration, they should receive no food except their mother's milk. Castration is usually done with a knife, and before attempting to castrate a pig the hands and knife should be washed and sterilized. Long incisions (1½ inches) should be made with the knife, and the cuts made well down so as to allow free drainage from the wounds. A little iodoform applied directly after the operation will help to keep away flies and possible infection.

When from eight to ten weeks old the young pigs should be weaned. If well grown and well fed they should weigh from 30 to 40 lb. each. A word of warning is necessary here because if weaning is delayed beyond ten weeks there is a danger of anaemia developing in the young pigs. At weaning the young pig's stomach is still very small and much care should be devoted to the feeding at this time. If fed too large amounts of food the stomach can be easily overtaxed and digestive disturbances result. Feed a little and often is the principle which should be followed.

A week before the pigs are weaned the food of the sow should be reduced to a minimum and this should be continued for a week after weaning. The object of this is to dry off the sow slowly and so reduce the chance of udder troubles developing.

MANAGEMENT OF WEANERS.

About a week after weaning, the pigs should be removed from the pen to a yard or paddock where they can obtain plenty of exercise and shade. If turned into a paddock, extreme care must be taken that the ground is clean and free from the eggs of the tapeworm. The natives employed for feeding and looking after the pigs should on no account be allowed to defecate anywhere in or near the paddock. Pigs are dirty feeders and for this reason they should not be allowed to roam about on free range as they are almost certain to come across human excreta and in this manner become infected. The eggs of the tapeworm when devoured by pigs, produce small bladder-like cysts in the flesh about the size of a pea, each of these cysts contains the head of a tapeworm. Pork infected in this manner is called "measly" and if eaten in a semi-cooked condition by humans may produce serious illness. Any pork infected is unfit for human consumption and should be destroyed. It is therefore up to the producer to see that his pigs are kept on a clean run, otherwise he may suffer serious loss through condemnation of carcases.

Exercise is essential for the production of the firm flesh required by bacon curers, and weaners should be allowed plenty of space until they are three to four months old, when they are ready for finishing and should be removed to the pens.

As a rule from four to six weeks in the finishing pens in sufficient to bring

the pigs up to the weight required by the bacon factory, i.e. 160 to 200 lb. live weight. Anything over this weight is too heavy for bacon and will in all probability fetch a lower price. Healthy well-fed pigs will gain weight at the rate of 1½ lb. per day. A mineral mixture should be available to weaners from the time they leave their mothers until they are ready to be sent to the bacon factory.

It may be as well to mention here the need for care when driving the pigs in the heat of the day. Pigs suffer badly from overheating. Overheating may cause fatal results or it may only cause loss of appetite and retardation of growth. In any case the pig will suffer a set-back which may be difficult to make up again.

HOUSING.

The best type of housing for all pigs in East Africa is a building constructed of stone or burned brick, with a concrete floor. Walls should be plastered with cement from the floor to a height of 4 feet, and the roof should be of thatch or tiles. Concrete floors are necessary owing to the presence of numerous jiggers in all earthed floor piggeries and many pigs seen by the writers in this country have been in a shocking stage through jigger infection. Concrete floors should be covered by false floors made from wooden planks. These planks can be removed from time to time and the floor thoroughly cleansed and disinfected.

Cement plastering on the walls is necessary to prevent the pigs from eating away the mortar between the stone or brick work and pig houses often get demolished in this way. Thatched or tiled roofs are more suitable than corrugated iron roofs as they are cooler in the hot weather and warmer in cold weather. All houses should be well ventilated. Each house should have a run attached. Pigs, although they have the reputation of being dirty, are probably the cleanest of all farmyard animals, and if provided with a run in addition to a sleeping pen, will invariably defecate in the run.

Clean straw should be provided at frequent intervals and pigs will then keep themselves clean by burrowing into it.

THE COMMON AILMENTS OF PIGS.

As stated before, pigs suffer from relatively few diseases, but there are a few which may be encountered in East Africa. Naturally, the description and treatment of pig diseases is outside the scope of this paper, and if a farmer has cause to suspect that something is wrong with his pigs, then the help of a veterinary surgeon should be enlisted.

The diseases which are most likely to affect pigs in East Africa are: swine fever, anthrax, and very occasionally tuberculosis. Internal parasites (worms) are the most frequent cause of illnesses in pigs, whilst much loss of condition is due to external parasites such as lice, ticks and jiggers.

The eradication of external parasites is in the hands of the farmer. Much can be done by having concrete floors and cement-plastered walls. These can be easily washed down and cleaned. Floors of earth, and unplastered mud brick walls provide a retreat for these parasites, and their eradication becomes almost impossible under such conditions.

To free pigs infested with any of these external parasites, the animals should be washed down weekly with a soap and paraffin wash. This is made up by cutting up ¼ lb. of soap into half a gallon of water and boiling until all the soap has dissolved. The water is allowed to cool somewhat and 1 gallon of paraffin stirred in.

TYPE OF
PIGGERY SUITABLE
FOR EASTERN AFRICA

As stated before the help of a veterinary surgeon should be obtained to deal with any of the other diseases of pigs, though on account of its widespread occurrence a little will be said concerning roundworm infection of pigs. This is one of the most costly diseases with which the pig breeder has to contend, and as prevention is better than cure a few notes will be given on this point.

The eggs of this worm, which are picked up from the soil and from the excreta of other pigs, are very resistant and so are difficult to destroy. The young pigs suffer most from the effects of these worms and it is to the young that preventive measures should be applied. The sow should be brought into a farrowing pen that has been thoroughly scrubbed out with hot water containing soda. The sow and particularly her udder should be washed free from dirt with soap and water, disinfectants are not necessary. Before being brought to the farrowing pen the sow should be freed of worms by dosing with oil of chenopodium (1 drachm for every 100 lb. body weight in 2 to 4 ounces of castor oil). Thus if the pen is kept clean the young pigs run little risk of being infected. Until they are at least three months old the young pigs should not be allowed on land fouled by older pigs.

THE FEEDING OF PIGS.

All pigs being fed for bacon or pork production must be fed regularly, either twice or even three times a day. Only sufficient food should be fed each time to allow the pigs to consume it completely within half an hour. The rations must be palatable; musty or bad feeding stuffs should not be fed. The appetite must be watched carefully and a change of diet made immediately there is any sign of the pigs going off their food. Once the appetite is lost it is difficult to get the pig feeding properly without loss of weight. Usually two full feeds daily with a small amount of exercise will be found the most economic procedure.

Meals should be fed mixed with enough water to make them just fluid and easy to pour out of a bucket. Excess of water in the meal is to be avoided, though free access to water should be possible in the heat of the day. The pigs must be housed in a cool place because overheating, from any cause, puts a pig off its food.

A small amount of green stuff should be given daily to pigs that are being fattened in houses. Fresh green grass, cabbage and canna leaves, sweet potato tops, and green maize or cereal crops serve this purpose admirably. This green stuff is best fed during the morning after the pigs have finished their concentrate ration.

To simplify the following description, details of feeding rates will be given in lb. of meal and the various types of rations that can be used will be given later. Whichever of the following rations is chosen the rate of feeding will be at the same rate per day as in the following notes: —

Feeding In-pig Sows.—In-pig sows should be fed as cheaply as possible. They may be turned out to graze on green grass and get 2 lb. of meal daily during the rainy season. Instead of grass, a paddock of cowpeas, velvet beans, etc., is a good place to run the sows. During the dry season, the sows may be allowed to graze through the crop residues left in the fields, but they will probably fare better if kept in an open yard. In the dry season they should get 4-6 lb. of meal daily according to their size, condition and period of gestation. In addition, about 2 lb. daily of beans or cowpeas steeped in water will ensure good strong

healthy piglings. The food should be improved during the last month before farrowing. About the time of farrowing the food should be fed as a thin sloppy meal and contain a higher percentage of bran. This same food should be given for two days after parturition, and in some cases a bran mash can be given with advantage immediately after farrowing.

Feeding Suckling Sows.—Three days after farrowing the sows can be brought back to normal rations and, at first will get 6 lb. of meal daily, but by the end of the week they will be getting 9 lb. daily. The ration should be increased slowly to satisfy the sow's increasing appetite and in the third week after farrowing she may need up to 12 lb. of meal. At this period the piglings begin to feed themselves and the sow's ration can be steadily decreased to about 5 lb. daily at weaning. After weaning the sows are put under the same conditions as in-pig sows.

Feeding Young Pigs.—At the age of three weeks, or even before, skim milk can be fed to young pigs with advantage. They should be taught to eat with small beans, cowpeas, or mbazi fed whole. During the fourth week the skim milk should be thickened with maize meal or a mixed meal. By the sixth week the peas, when scarce, can be discontinued and the young pigs should be given a good mixed meal. The amount to be fed is determined by the piglings themselves. No more than they will clean up quickly should be given. They also should be fed three meals a day, a little and often being the golden rule for feeding young animals. When weaned at eight weeks old the feeding should be given especial care, because it is at this stage that muscular development is most rapid and the stomachs are still small. Highly nitrogenous foods must be fed at this stage and all bulky foods omitted from the ration.

As the pigs get older feeding twice daily is sufficient. Besides their concentrate meal they should also get as much green food or roots (sweet potato or sweet muhogo) as they will eat.

Feeding Weaners for Bacon Production.—At the time of weaning when eight weeks old they should get 1½ lb. daily of meal with kibbled cowpeas or mbazi, if available (up to ½ lb. daily). By twelve weeks the food consumption should have reached 2½ lb. meal per day.

After twelve weeks of age the nitrogenous ratio can be widened and the daily intake of this new meal should approximate 4 lb. daily by the sixteenth week and 5½ daily by the twentieth week. From the twentieth to thirtieth week the ration should be increased from 5½ lb. up to 9 lb. daily.

Rations.—The standard economic ration throughout South Africa is nine parts of maize and one part of meat meal, with 3 lb. bone meal and 2 lb. salt added for every 100 lb. of the mixture. Pigs can be reared successfully on this mixture but its feeding is attended by the following disadvantages:—

(*a*) There is a tendency for the pigs to be finished in condition before they reach the required bacon weight.

(*b*) If pigs are forced on this ration the body conformation is seriously affected. There is a loss of uniformity in length, evenness, and thickness of back fat. The sides become shorter, thicker, and over fat.

(*c*) Maize tends to produce a very soft fat and although this tendency is corrected in part by the meat meal, the above ration will never yield 100 per cent good carcases.

This ration is fed to practically all types of pigs in the Union but better results are undoubtedly obtained by varying the nature of the diet.

An attempt has been made below to draw up alternative mixtures to suit the requirements of each type of pig. Each mixture should have 3 lb. bone meal and 2 lb. salt added for each 100 lb. of mixture. If this is not done then a mineral supplement should be provided for the pigs to take what they require.

In the following tables "cereal meal" means that either wheat meal, barley meal, or buckwheat meal can be used according to whichever is the cheaper or more plentiful. The term "legume meal" indicates that peas, cowpeas or beans, can be fed when ground into a meal. The term "cake" represents either groundnut or sesame cakes.

BOARS, SOWS, AND PREGNANT SOWS

A		B		C	
Maize Meal	70 parts	Maize Meal	60 parts	Maize Meal	40 parts
Wheat Bran	20 „	Wheat Bran	10 „	Cake	15 „
Meat Meal	10 „	Meat Meal	10 „	Cereal Meal	15 „
—	—	Legume Meal	20 „	Legume Meal	30 „

WEANING PIGS

D		E		F	
Maize Meal	60 parts	Maize Meal	50 parts	Maize Meal	70 parts
Meat Meal	10 „	Meat Meal	15 „	Meat Meal	5 „
Legume Meal	30 „	Cereal Meal	20 „	Cake	25 „
—	—	Legume Meal	15 „	—	—

FATTENING PIGS UP TO FIVE MONTHS OLD

G		H		I	
Maize Meal	60 parts	Maize Meal	55 parts	Maize Meal	60 parts
Meat Meal	10 „	Meat Meal	5 „	Cake	20 „
Cereal Meal	30 „	Cereal Meal	20 „	Cereal Meal	20 „
—	—	Legume Meal	20 „	—	—

FATTENING PIGS OVER FIVE MONTHS OLD

J		K		L	
Maize Meal	55 parts	Maize Meal	50 parts	Maize Meal	55 parts
Cereal Meal	35 „	Cereal Meal	45 „	Cake	20 „
Meat Meal	5 „	Meat Meal	5 „	Cereal Meal	25 „
Wheat Bran	5 „	—	—	—	—

These are naturally only specimen mixtures but they serve to show how a gradually widening nutritive ration is required as the pigs pass from the weaning to the slaughtering age. In all the above rations, maize has been taken as the basal food-stuff, but this can be replaced by millets whenever so desired. The millets must be ground however, because recent experiments at Mpwapwa have shown that unground millets pass in large amounts, undigested through the pig's alimentary tract. Any farmer can vary the above specimen rations so as to include the various waste products of his farm, such as garbage from the house, potatoes, native-produced brans from maize and millets, the residues from the making of native beer, fallen fruits, etc.

Variety is the secret of maintaining the palatability of a ration, if the appetite falls lowered rates of live-weight increase result and the pig becomes less economical. In this connection, experiments of the writers show that those rations which contain an animal protein food-stuff (meat or blood meal or skim milk, etc.) are much more palatable than mixtures not containing proteins of animal origin.

Pigs normally eat less of such mixtures containing no animal proteins, and the rate of fattening is therefore slowed down. On the other hand the very high cost of such animal by-products prohibits their use in certain districts and more economical gains are made on the slower fattening rations. These points must of necessity be left to the farmer to settle for himself, after paying due regard to the local food supplies and to the cost of those foods he needs to buy in from outside to balance his home-grown supplies.

With the development of a dairy industry in certain districts of East Africa (notably the Kenya Highlands) it would be wrong not to mention the extraordinary value of separated milk for pig-feeding purposes. Many farmers are now supplying cream to creameries and are left with large amounts of separated milk upon their farms. Skim milk can be given in small amounts, after being warmed to body temperature to young pigs three weeks old. This helps to supplement the sow's own milk supply and maintain a good rate of growth in the young pigs. Care should be taken to introduce the skim milk very slowly into the young pigs' ration because sow's milk and cow's milk differ considerably. If introduced too rapidly, cow's milk causes scouring and loss of condition in the young pigs.

Once young pigs have become accustomed to cow's milk, it can be given in increasing amounts up to the time of weaning. A balanced ration can be designed for all types of pigs using only skim milk, maize, and a mineral supplement but this is not advisable for weaners. From the age of 8-12 weeks the young pigs should be given a pint of skim milk daily with 1½-2 lb. of a meal mixture such as that shown in Table D. After the age of three months the pigs can be reared on corn and skim milk. The rate of feeding these two food-stuffs so as to obtain a balanced fattening ration is as follows:—

12–16 weeks	2·5–3 lb. Skim milk to every 1 lb. of maize.
16–20 weeks	2–2·5 lb. Skim milk to every 1 lb. of maize.
Over 20 weeks	1·5–2 lb. Skim milk to every 1 lb. of maize.

A mineral supplement of 3 lb. bone meal and 2 lb. of salt should be mixed with every 100 lb. of maize used for feeding in conjunction with skim milk.

Skim milk not only stimulates the appetite, but helps to counteract the softening influence of maize on the fat of the bacon carcase. In the above remarks only maize has been discussed for use in conjunction with skim milk. Where it is possible to replace some or all the maize with a hard grain such as barley a very much superior carcase will result.

As the quality of the carcase is so greatly affected by the nature of the food-stuffs supplied to the animal it may be stated that the various feeding stuffs have the following effects. Barley produces the finest quality bacon, particularly when combined with skim milk feeding as is done in Denmark. Oats, peas and beans also produce carcases with a high percentage of lean to fat and with a fat of good consistency. Skim milk, butter milk and whey in combination with cereals make good bacon. Maize, groundnuts and rice by-products all tend to produce a soft bacon, with an oily fat. Good pastures or green leguminous crops produce good carcases containing a high percentage of lean meat to fat. Too many succulents, combined with too little concentrates, produces a soft bacon, but when used in rational amounts, succulents can be of great value for bacon production. Owing to less efficient extraction of the oil, the oil mill residues produced in East Africa contain too much oil and as a result tend to produce a soft fat in the pig. The fat of meat meal on the other hand hardens the fat of the pig.

By avoiding a ration which contains too much of the soft fat-producing feeding stuffs a pig farmer can expect to get good quality bacon so long as he supplies an adequate amount of protein, particularly at the weaning stage.

Recent experiments in England indicate that the relative proportions of lean meat, bone and fat is determined by the feeding at the weaning stage. Good rations, containing the optimal amounts of protein and mineral matter cause a good development of lean meat. On the other hand underfeeding , or feeding badly balanced rations at the weaning age, results in a retardation of muscular development, and in the final carcase, space which should have been filled with lean meat is occupied by fat.

(*Continued from page* 412)

The Weather of 1935

combined with the somewhat low temperatures were the result of the uninterrupted flow of cold and fairly dry air from the south and south-east.

The "short rains" over the greater part of Kenya started about the 10th of November when a wave of air of greater moisture content spread from the Lake. Showery conditions appeared over Tanganyika and to the south about the same time.

A noteworthy occurrence was the onset on 25th and 26th December of heavy thunderstorms over the greater part of the country and especially between the coast and the Kenya Highlands. The showery conditions persisted until well into January and were a very welcome addition to the rainfall in many areas. The reason for this somewhat exceptional weather is still being investigated, but it was probably the influx of cool but moist air from the west (possibly the Altantic) which caused the very unstable conditions and the resultant rain.

Mixed Farming in East Africa

I—Grassland and Arable Dairying in Certain Parts of Kenya

Timbora—Molo, Upper Gilgil—Thomson's Falls, Njoro—Rongai—Subukia

By R. S. BALL, *Dip. Agric. (Cantab.), A.I.C.T.A., Agricultural Officer, Kenya Colony.*

The great increase in dairying in this country, more particularly in the arable districts, has called for a close study of its relation to both arable and grassland production.

It is of great importance to lay emphasis on the fact that improvements in grassland and feeding must go hand in hand with improvements in the type of animals kept. It is obviously useless to ranch high grade cattle on veldt grazing where perhaps 15 acres are required to maintain one beast, since the animals will have to walk too far to obtain the necessary food, and will therefore be incapable of approaching anything like their maximum production. In contrast, it is obviously useless to expend much money on the improvement of grazing and forage crops when a native herd capable of averaging less than half a gallon of milk daily is being kept. Such animals are probably best ranched out, and it may even be doubtful whether it is worth while providing any additional feeding at all, the herd being dried off in the dry season and calving only when the rains commence. As the lactation of such animals is usually short it is possible to arrange this fairly easily.

The most important question that arises at the outset is therefore as to what level of production should be the aim of the average dairy farmer. It is obvious that in countries such as Great Britain, where the majority of the milk is sold for liquid sale at a relatively high price, heavy concentrate feeding is profitable and there is therefore very little limit to a herd average. Actually, the high yielding herds averaging over 900 gallons have proved extremely profitable.

In this country, however, where the majority of the milk must be converted into butterfat at a relatively low figure, the economic limit is reached before heavy concentrate feeding has to be practised. For this reason, the ultimate aim should probably be a herd average of about 400 gallons, which is likely to prove most profitable in Kenya. This level can be maintained largely by the use of feeds, both concentrated and roughage, produced almost entirely on the farm with perhaps the addition in the case of the higher yielding cows of the locally produced relatively cheap oil-cakes. For producers who are able to sell liquid milk in this country, a higher level of production may be economic, but these are of necessity a small minority.

It is obvious that it will require a considerable time to reach this standard, particularly in areas where disease is rife, and in which it would be unwise to introduce high-grade stock until the land had been thoroughly cleaned up by the use of immune cattle, fencing and the dip. The need for a united policy in "dirty" areas, or even in any area where dairying is expanding rapidly, needs no emphasis, in order that collective action may be taken over such matters as disease control; since even with fencing and dipping there is a risk from non-immune working oxen and the natural fauna.

Standards such as those mentioned above can be attained easily without any loss of constitution in the progeny, and it is interesting to note in this connection that one or two farmers who have exceeded this standard have noted a falling off in the constitution of the progeny rendering it necessary to revert to the use of lower-grade bulls so as to restore some of this lost robustness. Another advantage of a standard which is not impossibly high lies in the fact that in many cases fairly large numbers of animals are required in order to utilize available grazing, and forage crops which can be produced at very low cost. The use of cattle in the arable areas is by no means confined to their value in producing ready cash, for, with the falling fertility of arable lands, there is an ever-growing need for the restoration of humus either by the use of dung or by the grazing of arable lands which have reverted or been sown down to grass, and the advantage of numbers of cattle in this case needs no emphasis. A statement such as this latter, may, however, need modification in certain areas such as the soils rich in humus, such as those in the Elburgon or Limuru districts, where land has to be or has been cleared from tall forest at high cost, or where it is valued at a high figure per acre, and where therefore the farmer will seek to produce the maximum possible cash value per cow. These particular problems as confined to individual areas, will, however, be dealt with at a later stage in this article.

HOUSING.

There is a considerable amount of discussion at the present time about the systems of milking and of housing milking cattle in this country. The use of portable bails has been recommended in many other countries and finds wide application there, but it has very severe limitations in Kenya. The chief of these is the need for supervision. If a permanent bail is erected near the homestead supervision is rendered easy, particularly on the mixed farm where the farmer has much other work on hand, and thus proper attention can be paid to the hand-rearing of calves. On the other hand, it is necessary to ensure that the cattle are collected in a dry compound for milking, and are not kept standing about in deep mud. The dangers to cows of straining through mud are not often realized; many cases of abortion have been traced to this factor alone. Choice of site is therefore very important in the construction of the permanent milking shed, and a metalled road from the fields should lead to the collecting compound, which should itself be paved if possible. Many farmers will not wish to incur the heavy expense of paving, where stone is not readily available, but this difficulty can be overcome by adopting the principle of the English cattle yard, by putting in a quantity of fresh litter daily, maize trash, wheat straw, etc., and allowing this to accumulate to the height of several feet before clearing out. In this manner the cows are always comfortable while waiting to be milked, and excellent dung is obtained for the arable lands. A further disadvantage of the permanent milking bail is the distance that it may be necessary for the animals to walk to and from grazing and water, which is likely to affect milking cows adversely. These difficulties can, however, in large measure be overcome by paddocking near the milking unit and grazing off laid stock (dry cows, heifers, etc.) further afield. The very important item of supervision will therefore in many cases make a permanent milking shed essential, and its disadvantages can in most cases be overcome on the lines described above.

The movable unit has its uses, however, particularly where ranching conditions obtain. It necessitates a fairly well-watered farm and a travelling hut containing separator and cooler to follow round with it. Under these ranching conditions, calves will probably not be hand reared and therefore absolutely strict supervision is not essential. It is necessary that the unit should be complete, and that the milk should not have to be transported a long distance to the separator. There is, however, one further limitation to the portable unit in this country, namely, that on certain types of grazing in particular red oat grass treading may destroy the grassland instead of improving it. On the type mentioned there will be a tendency to produce the course Pennisetum stage, without carrying it to the final Kikuyu grass stage. The advantage of the system lies of course in the fact that the cattle are always on fresh land, so that paths and roadways are not trodden out, which cause wash and erosion.

Having decided on the general scheme to be adopted, the layout of the farm for dairying, and the grading up policy (or a policy of purchasing grade cattle from the start, this depending largely on disease, food available and other factors), it becomes necessary to make some choice of breed. There is, of course, a never ending argument about breeds, but the position can be very briefly summed up in the words "Choose one breed and stick to it", so that the policy may be a consistent one and the segregation of bad types may not occur. It is important to remember, although fairly obvious, that a big-framed big-barrelled cow obviously requires more feeding and minerals than a smaller type. There is always argument as to whether one should choose a breed the milk of which has a high butterfat content, since this is the main object, or whether one should choose a heavy milking breed, rather at the expense of butterfat. In many cases the two factors balance out so that the problem is not of the magnitude that is frequently stated.

It has been observed during the past two dry seasons that grades of the Channel Islands breeds have kept their condition in the most remarkable manner under very adverse conditions. This, however, is not necessarily an argument in favour of these breeds, except possibly under ranching conditions, since feeding during these adverse periods will be the main pivot of a farmer's policy. For the farmer who is starting it is obviously desirable that he should choose a breed already well represented in the country, so that he may have a good choice of stock bulls and there can be no possibility of in-breeding. Bearing all these points in mind, the actual choice will rest largely on individual preference. There has been a desire in some areas to adopt one breed throughout the district, so that a communal use may be made of an expensive bull by all the farmers who would send their best cows to him, whereas each individual would be unable to afford such an animal for himself. This is, however, by no means an unmixed blessing, as experience in England has shown, owing to the chance of spreading such diseases as contagious abortion, and, on the whole the disadvantages probably outweigh the advantages.

This article has dealt hitherto largely with generalities, capable of application to any dairying district, but owing to the very special conditions obtaining in each area, detailed examination of each type of grassland, the possibilities it provides for cattle, and the necessary sup-

plementary feeding for the maintenance of milk yields, together with the fodder crops that can be grown in each area, must be described. For all districts, however, silage is likely to prove a very valuable standby in adverse periods as a succulent food, correcting the binding effect of dry grasses, and therefore some general notes about silage and silage crops are introduced at this stage.

SILAGE.

One of the chief objects of silage-making is to attempt to preserve in a mummified form, for as long periods as possible, the succulent green material grown during the rains. Great advances have been made in the technique of silage-making in Europe in the efforts to preserve the material in this mummified form without incurring severe wastage. The most notable of these is the Tor-Silon process which aims at the sterilization of the material so that no bacterial action may take place. This process is by no means perfect at present, and is not likely to be of application to the ordinary pit silo as used in this country. The chief improvement which every farmer can adopt is the use of raw cane sugar molasses when ensiling protein-rich material. This does not stop bacterial action, but encourages it on the right lines, so that the formation of sour-smelling butyric acids is prevented. When ensiling carbohydrate-rich material the addition of molasses is by no means essential, though desirable in that it controls the bacterial processes. The practice is to sprinkle on the molasses in solution at the rate of ½-1 per cent as the pit is being filled. Failure to make good silage in this country is due in a great many cases to a bad choice of site for the pit. Too often it is placed in such a postion that water can drain in readily, immediately turning all the silage very sour. It should be always placed where there is no possibility of incursion of water. Good silage can be made without chaffing the material up, provided it is laid end to end in the pits, and not just thrown in higgledy-piggledy. If it is carefully laid, and this applies particularly in the case of maize, air will be excluded almost completely, and a good silage will result. Of course, it is always desirable to chaff the crop if possible, particularly where the acreage that can be devoted to silage crops is limited, since much less waste will be entailed in the feeding of the material, as the whole of the stem will be eaten in the case of maize. Although maize is likely to be the chief silage crop in this country, yet at the higher altitudes over 7,000 feet crops of oats and peas grown in mixture or alone usually yield a heavier tonnage to the acre. Lucerne also can be ensiled, provided molasses is used as well since, owing to its high protein content, it is liable to turn sour if carbohydrate is not added.

A crop of maize should yield about 10 tons of silage to the acre and, at the higher altitudes, the oat and pea or oat and vetch mixtures should yield at least 8 tons per acre. Maize should always be planted thicker than the normal crop for silage so as to prevent it from becoming too stemmy, and should be ensiled when the cobs have formed and the grain is just coming into the milky stage. Oat and pea or oat and vetch mixtures should be ensiled when the oats are in the milky stage, and the peas fully in pod, or the vetches fully in flower. Practically any crop including grass can be ensiled, with the exception of the *Brassica* (cabbage) family, which, on account of their high moisture content invariably yield a sour evil-smelling material. If the crop is rich in protein, molasses should be added as

has been described above. Most crops are ensiled when they are flowering and coming into seed, for, under these conditions, the moisture content will not be excessively high, and the material will not turn sour. Napier grass, however, is seldom ensiled in a state of maturity and therefore care should be exercised when putting it into the silo. Molasses should be added and great care taken to exclude all air by heavy treading, and dragging of the carts through the pit. For purposes of calculation of size of silage pits, it may be reckoned that silage weighs from 30-50 lb. per cubic foot, and that an animal in milk giving up to two gallons per day may be fed from 15-30 lb. of silage daily, the actual amount depending on the other foods available. Calves and younger stock can be fed smaller amounts, for silage is a food palatable and digestible to all classes of horned stock. Provided the material is sweet, there is little danger of it tainting the milk, and it can therefore be fed to the cows in the milking bails and rationed to each animal according to its requirements. If, however, it has a sour smell, it is liable to taint the milk, and should therefore be fed outside the milking sheds. In conclusion, it is perhaps desirable to emphasise that, during dry periods, however much good hay may be available on the farm it is necessary to provide silage for the cattle in addition, since some succulent food is essential in order to prevent the animals from becoming constipated and impacted, and to maintain the flow of milk.

High-Altitude Rich Forest Soil, Kikuyu Grass Areas.

Such conditions are to be found at Elburgon and district, in Limuru, and other parts. The farms are usually limited in size, either owing to the high cost of land per acre or the cost of clearing high forest. These areas have great potentialities from the point of view of dairying. Rainfall usually provides plenty of grass most of the year round and in fact during the heavy July-August rains, in the Elburgon district the disadvantages of Kikuyu grass become most apparent, for there is a great tendency for the cattle to scour very badly and for blowing to occur. One of the problems is therefore to provide foods that will correct this tendency. The amount of land available is frequently a limiting factor for the reasons mentioned above. The aim of the farmer will therefore be to secure a very high output per acre and the numbers of his stock will be limited. Some of the available land should therefore be devoted in many cases to growing oat hay to be used for feeding when the Kikuyu grass is very watery, and under these conditions yields of 3 tons to the acre of hay are obtained. Lucerne may also be grown for feeding to young stock and dairy cows, and is made into hay. It is essential to dry it in a store, as, owing to the very heavy rains it is usually not possible to build it round tripods in the field and dry it in this manner. Irrigation is usually unnecessary as lucerne will grow practically the whole year round. Horse beans can be grown well on these soils, provided bees are available in the neighbourhood, and these may be crushed up to make a protein-rich concentrated food for the stock. The haulm and leaf are also valuable, since they are rich in protein. Field peas also grow well, and quite good results have been obtained from inter-planting in maize where the farms are not too high for this crop. A certain amount of silage may also be made as a provision against the short dry season and the possibility of locusts. High yielding cattle can therefore be fed almost entirely on foods

grown on the farm, with the possible exception of a small amount of purchased cake for the heaviest milkers. Under these conditions a somewhat higher level of milk production than for more extensive farms should be aimed at owing to the limited amount of land frequently available. All the land will be paddocked so as to keep the Kikuyu grass well grazed, and it is desirable to have sheep to follow the cattle, to keep the grass grazed down tightly.

It may be desirable to establish a certain amount of Australian Rhodes grass in parts of these areas, chiefly for use of the cattle during very wet periods, and also for cutting for hay. Feeding under these conditions does not present a great problem owing to the very wide variety of crops that can be grown.

High-Altitude Red Oat Grass Areas—Soils of Low to Average Fertility.

This type is probably typical of a very large area ranging from 7,000 to over 10,000 feet, up to the limits of the settled areas and embraces such areas as Molo, Mau Summit and Timboroa, Thomson's Falls and Upper Gilgil. There is often a fairly prolonged dry season, and the grazing presents very peculiar problems. Much of the land is primarily suited for large scale ranching, for heavy grazing tends to destroy the red oat grass herbage, giving a coarse *Pennisetum* stage in its place. In many parts of these areas, it is possible to establish Kikuyu grass by very heavy concentration of stock (in order to raise the humus content of the soil to the high level required by this grass) and treading, but this may also entail destroying a considerable acreage of oat grass in the vicinity of this heavily stocked land. Furthermore, the concentration of stock required to produce Kikuyu grass is also likely to be very heavy and on the poorer soil types it will probably be necessary to manure it heavily with *boma* manure when once established. There is some doubt therefore as to whether it is likely to be a practicable proposition to establish Kikuyu grass on the poorer soils by treading out the veldt with heavy cattle concentration. The position may be summed up by saying "it may require more cattle to carry the Kikuyu grass than the Kikuyu grass will carry cattle."

Apart from the question of the introduction of Kikuyu grass, the use of exotic grasses shows promise in the highest of these areas, that is of 8,500 feet and over. These are sown down on arable land, usually old wheat land that has become infected with "Take-all", or alternatively land may be ploughed up for the purpose. The most promising grasses to date have proved to be Italian ryegrass, perennial ryegrass and cocksfoot, also Australian *Phalaris tuberosa*, and their yields under grazing conditions have proven satisfactory.

For the lower limits (below 8,500 feet) of this high altitude area of poor fertility a large number of grasses are still under trial; results to date however indicate that Australian Rhodes grass is likely to be of considerable use and may take the place of the other exotic grasses mentioned for the higher limits; *Panicum maximum* (guinea grass) is another of those grasses still under trial which shows promise, though it is not possible yet to be as definite as in the case of Rhodes grass.

The further problem connected with these areas is usually that of the supply of water and the distance the stock have to walk to and from water and milking is often very considerable. However, in most cases large catchment areas are available, and the construction of dams offers great possibilities. The use of port-

able milking outfits in this area would of course be highly desirable, but great care must be exercised that the oat grass is not trodden out and the coarse *Pennisetum* stage brought in.

The dry season is of varying duration and intensity throughout these areas is usually most intense at the lower limit of altitude in the class of district under review. Reverted arable lands in these areas, which have often been devoted to wheat, usually go back to mixtures of Kikuyu grass and other indigenous couches, which will provide satisfactory grazing. A method commonly adopted is to sow the last crop on a field in oats as usually the grass herbage seems to come in most readily under this crop, and with least growth of weeds. Kikuyu grass can be established in this manner much more readily than by the concentration of stock on the veldt itself. If necessary also it can be planted from runners before the land goes back to grass. Its successful maintenance will depend on heavy grazing and concentration of stock at night. The Agricultural Officer in charge Grassland Improvement has dealt fully with the subject of the establishment of Kikuyu grass in an article published in the *Empire Journal of Experimental Agriculture,* Vol. 3, No. 10.

Abundant hay can be made for the dry season from the veldt, provided it is sufficiently level and free from mole hills, etc., to enable a mower to be used. The best practice is to mow the land once and then to allow the grass to grow again, so that the second cutting is used for hay; in this manner the grass cut for hay will all be fresh. Veldt hay must be made quickly, as the swathe is always very thin. It should be gathered up into windrows the same day it is cut, and then put into "pikes" to dry out. If it is not won in first-class condition a certain amount of salt, about 10-20 lb. per ton of hay, should be introduced as the stack is built, scattered in layers on the stack. The type of veldt prevalent in this area probably does not average more than about 8 cwt. of hay to the acre. Veldt hay should always be stacked in as large stacks as possible so as to induce a slight heat which improves the quality. It is very common to hear that animals will not eat veldt hay, and this is nearly always due to the fact that it has lain in the field too long, and become badly bleached. Unless it retains its green colour when put into the stack, it is fairly certain that it will be of little value, if any, except as a source of useless fibre.

In these areas succulent foods for the dry season will largely comprise silage made from mixtures of oats and peas or oats and vetches. For this purpose the oats should be sown down at the rate of about 35 lb. per acre, and the peas drilled in them about three weeks later at 70-80 lb. per acre. The whole may then be cut together when the oats are flowering and the peas in full pod. Alternatively the two crops may be grown separately, when the usual seed rates for these crops would be used. Purple vetch is also a valuable crop for including in mixture for silage or it may be cut for hay. It is usually sown at the rate of about 26 lb. per acre, and a light seeding of oats should be included with it so as hold up the mixture of crops and prevent the material from balling on the fingers of the mower. Napier grass can be grown satisfactorily only at the lower limits of these areas, as it usually suffers severe damage from frost at higher altitudes, and grows slowly. The kales and cabbages can also be grown in these districts, the damage from sawfly caterpillar which almost precludes their growth at

lower altitudes not being so severe, although liable to be quite appreciable. A word of warning is, however, necessary with regard to these crops. Owing to the fact that they may have a certain number of drying leaves on them when fed, it is quite common for the milk to become tainted particularly with cabbages, which will of course lead to degrading of the cream. Further, some of them, such as rape have tended to become bad weeds of arable land in these areas due to the rapidity with which they seed. A farmer producing liquid milk is however well advised to grow the kales, since they impart a yellow colour to the milk giving it an appearance of great richness.

One other forage crop is worthy of mention for these areas and that is Hubam clover. Its chief value lies in its great drought resistance, although it does not produce a very heavy bulk of herbage to the acre. It grows very slowly at the start, but can be cut several times although usually considered to be only an annual. Farmers often state that it is unpalatable to cattle, but once the animals have become accustomed to it they relish it very much. It may be necessary to add a dilute solution of molasses to the Hubam clover the first time it is fed so as to encourage them to take it. It has the advantage of being highly laxative, a most desirable character in the dry season for correction of the effects of the veldt herbage.

The conclusions with regard to these red oat grass areas may be briefly summed up by stating that development is required on the lines of improving the water supply by means of dams, by the improvement of grazing either by encouraging the use of exotic grasses planted on arable lands or by the establishment of Kikuyu grass. The indigenous veldt must be kept from being overgrazed as far as possible by more efficient utilization, this factor being largely controlled at present by water supply, so that off-laid stock may graze in rotation over the whole area without concentrating too heavily on any one part of it. Finally silage crops must be provided for the dry season, and if possible oat and veldt hay in addition. The possibilities of the use of portable milking outfits must also be explored bearing in mind the limitations of the system. In its natural state most of this grazing will carry about one beast to 5-6 acres. The unimproved veldt might be described as being fair "store" grazing. It should be remembered that most of these areas are highly suited to sheep (Kent or Romney Marsh) and the value of them as "followers" on reverted arable lands is great. It is, however, essential to keep such weeds as the forget-me-not out of the land to prevent damage to the wool. It must again be emphasised that the successful management of these reverted arable lands will depend largely on heavy grazing and stock concentration, without which the herbage will revert to a more or less useless series of volunteer grasses. It is probable that in the areas of lower fertility, it is not a practicable proposition to establish Kikuyu grass on veldt by stock concentration. Under rich soil conditions, however, this practice may be justified.

Lower Altitude Areas with Prolonged Dry Season.

The unimproved veldt in these areas, which are typified by the Rongai Valley, comprises largely red oat grass which, on treading and heavy grazing, gives place to star grass. Derelict arable lands revert to a mixture of star grass and Rhodes grass, the latter predominating on the lava ash type of soils, but on other soil types a fair balance is maintained.

Where the soils contain a large amount of soda, however, the star grass is the predominant grass, and this particular soil type invariably yields the best grazing, and is usually an exceptionally good fattening grass. The chief problems in these areas are very prolonged droughts which may lead to overgrazing of the pastures. For this reason the carrying capacity of the pastures can never be as high in actual practice as it could in theory, for probably much of the grass on the soda soils would carry a beast to 2 acres were it not for this limiting factor of drought. The incidence of drought is uncertain for, apart from the usual rather prolonged dry season, dry periods occur at odd intervals. It is essential to be prepared at all times in these districts for an adverse period, and for this reason silage is a great standby. Good hay can also be cut, particularly off the reverted arable lands, and Napier's fodder grows exceedingly well. The *Brassica* crops are very difficult to establish on account of the sawfly, and yields from lucerne are usually very poor, unless the crop can be irrigated, which is not usually practicable. A large range of exotic grasses have been tried in these areas, the most suitable of which has proved to be the Australian strain of Rhodes grass. All the English grasses have proved unsuitable on account of the high evaporation, and many others, such as *Phalaris tuberosa, Paspalum dilatatum, Bromus marginatus,* have proved incapable of withstanding the long dry season and intense evaporation. Other indigenous and exotic grasses from Kitale and elsewhere have been tried, of which molasses grass, Golden Timothy and *Brachearia* spp. have shown great drought resistance. It is doubtful, however, whether any of these species are likely to prove superior in feeding value to the grasses indigenous in Rongai itself. Two other grasses, *Cenchrus ciliaris* and woolly finger grass are showing fair promise under Rongai conditions, but they are still in the experimental stage and concrete recommendations cannot as yet be made about them. Chief reliance must therefore be placed on indigenous grasses, which are extremely good, and the introduction possibly of a certain amount of Australian Rhodes grass as hay and grazing. The reversion of arable land in this area provides a cheap and practicable means of securing good grazing, although it is probably desirable to plant star grass in these areas before the land goes back, so that a good cover may be rapidly obtained. It is also desirable to plant a certain acreage of such land with Napier grass which may be used for grazing purposes in addition to cutting it as a green forage. Hubam clover does well in this locality owing to its very great drought resistance, and Uba cane is likely to prove its value as a succulent and highly palatable forage crop, the only drawback being that its growth is slow as compared with Napier grass. Trials have been made of certain varieties of pumpkins, and these have yielded satisfactorily in a dry year. Although the feeding value is not high, yet, since they can be stored for two months or so, they are of great value as an extremely succulent food, and also save a certain amount of water, which may in itself be of value in the dry season. The milking unit in this area will usually be a permanent one, this being determined largely by the water supply, which is the limiting factor in dairying, although results from boring have shown that it may be possible to increase the amount of water available for cattle. If dams are constructed in this area it is absolutely essential to provide heavy overhead shade so as to lessen the

evaporation from them in the dry season. Shade is also most important for the cattle in this district owing to the intense heat of the sun during the day, and the indigenous thorns provide in most cases a very good shade cover. On reverted arable land, however, it may be necessary to provide and plant special shade trees and belts, as yields of milk are nearly always reduced if the cattle have to stand out in the sun during the heat of the day. With reference to concentrated foods, maize, soya beans, and linseed can all be grown successfully in the area. Oats are usually unsatisfactory on account of the very small amount of kernel in the grains, but good crops of barley can be grown, and this may be utilized in mixture with other foods as concentrates. It is worth noting also that owing to droughts and other causes a considerable amount of very low grade wheat has been grown in these areas in the past two years. Such wheat is rich in protein, and its only drawback as a cattle food is its sticky nature so that it should not comprise more than a quarter of the concentrate ration. While on this subject, a note on the preparation of concentrated foods may be not out of place. The cereals, oats, barley and wheat when fed to cattle are best crushed or rolled and should not be ground into a meal, this applies particularly to wheat. Maize on the other hand should be gristed into a coarse meal, but should not be fed kibbled as it will pass straight through the cattle in this state. It is much better to grist maize coarse than to feed it in the fine state usually associated wtih *posho*, and it costs less to prepare it in this manner. Beans and linseed are best fed crushed, and at all times it is desirable to feed beans in some form to both young and adult bulls, as it is popularly supposed to increase their fertility. When crushing linseed, it is advisable to incorporate some maize as well, otherwise it will tend to stick on the plates owing to the exudation of the oil. Every dairy farmer should use a mill fitted with rollers so as to be able to roll or crush the cereals, this being much cheaper and requiring less power than grinding. With the introduction of hammer mills, it is possible to grist maize on the cob, and this forms an excellent food for dairy cattle as part of their concentrated ration, being less sticky in nature than maize by itself.

The problems in these lower altitude areas may be summed up briefly by saying that adequate provision must be made for unexpected dry periods, in addition to the ordinary dry season which is of severe intensity. Both reverted arable lands and paddocked indigenous grassland yield good grazing, of high stock-carrying capacity, the limiting factor being rainfall. The area is fortunate in that a wide range of forage and fodder crops can be grown, the most important being Napier grass and maize for silage. In addition, foods suitable for feeding as concentrates can be grown on a fairly wide scale, and young stock particularly grow out much better than they do on the high oat grass veldt, where they nearly always fall back in condition when first weaned, unless heavy additional feeding is practised. The reverted arable lands in the wetter parts of this area tend to grow a large amount of bush and scrub and, unless this is attacked from the start and rigorously uprooted, may eventually destroy the grazing almost completely and render the land very costly to bring back into cultivation.

The three main types described above are representative of the majority of grazing throughout the area under consideration, but everywhere intermediate

types are to be found. Thus the type described as being representative of the drier lower altitude areas is modified considerably in wetter areas such as parts of the Subukia Valley, where growth is much more rapid, and a considerable number of forage bushes such as *Indigofera* spp. and *Crotalaria* spp. appear in the grass herbage. The star grasses and couches in this area are often to be found in mixture with Kikuyu grass on reverted arable lands, and the mixture is found to be highly laxative during the rains so that much the same problems arise as in the pure Kikuyu grass areas described above, necessitating corrective feeding during the rains. Again, in the drier areas of the Subukia Valley, the incursion of young thorns and Mulelishwa makes use of much of the available natural grazing and appears to increase very rapidly as grazing becomes more concentrated. In such districts it is probably advisable to make use of some of the reverted arable lands for paddocking purposes, and to ranch the veldt with store stock. In the Njoro district where the red oat grass-Kikuyu grass succession is very slow indeed and requires much more time and concentration than at the higher altitudes, and even then is retarded by the slow growth of the grass itself, indigenous grasses have proved very promising; in particular Australian Rhodes has been successful and also *Phalaris tuberosa* with a low stooling lucerne as a possible leguminous constituent. In this area, however, much use can be made of reverted arable lands which yield a useful herbage very rapidly, in fact Kikuyu grass appears to persist on them as long as the aerated conditions of semi-arable cultivation persist and heavy concentration of stock is practised.

A further type of grazing is to be found on the lava ash Menengai soils where arable lands revert to a mixture of Kikuyu and Rhodes grass and indigenous clover during the rains, the latter predominating after a few years. In these areas close paddocking of such lands has proved very beneficial and farmers who previously had been afraid of Nakuruitis can now feed dairy cattle in these paddocks, provided an adequate mineral supplement containing iron is supplied also.

All these types of grassland are, however, merely intermediate between the three chief types described above, and the gradation from one to the other can usually be traced. Thus the Menengai type of grassland can be traced as it gradually passes into the Rongai type, and the star grasses make their appearance in the Rhodes grass herbage of the derelict arable lands, and Kikuyu grass disappears completely. The problem of forage crops in these intermediate areas is readily solved since their range is in nearly every case widened to include those of the type both above and below them. Thus at Njoro it is possible to grow Napier grass, oat and vetch and oat and pea mixtures, Hubam clover, kales if necessary, soya beans, maize, linseed, etc., so that feeding problems are fairly readily solved.

The work hitherto carried out in these areas has therefore shown the broad lines on which dairying may be developed, in these areas the methods of grassland improvement to be adopted, and the forage crops suited to the respective districts. Our knowledge is not, however, by any means complete at this stage, for it is essential to make some determination of the feeding value of the grasses both indigenous and exotic at different times of the year and under different conditions of rainfall. Until some estimate of these values is obtained, it will be impossible to determine accurately the

correct rations for feeding to cattle at different times of the year and these can only be suggested on very broad lines and very tentatively in the present state of our knowledge. It is a little difficult to apply figures from other countries where such work has been carried out for there is known to be a very wide variation in feeding values, influenced by climatic and soil factors. A few suitable rations for the areas described above are appended below but their limitations are obvious and they are put forward purely tentatively.

The importance of feeding minerals to cattle needs no emphasis in this country, and many farmers are now wondering whether some of the difficulties they meet with in getting their cows to hold to the bull may not be due in part at least to the inherent deficiency in minerals of all foods fed. Although there is no definite information on this point yet it is possible that it may have some bearing on this subject.There is a very large loss annually at present due to this difficulty of getting cows in calf, and it is not infrequent to find 40 per cent of the cows dry and laid off. For this reason farmers are tending to serve their heifers very young, as there is little doubt that they are easier to get into calf in this manner, and provided they are given a reasonable dry period before the second calving and have been fed as heifers, do not appear to be permanently stunted or to cease growing. The whole question requires further elucidation.

The most important minerals are salt, phosphate, lime, iodine and iron, the latter particularly on lava ashes. It is best to incorporate thes constituents in a mixture, as if rock salt is fed alone, it is liable to be stolen by natives. For heavy yielding cows and heifers with first calf, some phosphate should be included in the concentrated ration fed. One farmer known to the writer doses all his heifers frequently with phosphate, so as to ensure that they receive an adequate amount. This has of course a further advantage in that the animals become accustomed to being handled and are therefore much less likely to be difficult at calving time and to hold up their milk. Animals probably do not receive sufficient handling in this country prior to calving, with the result that their legs have to be tied when milking. An animal standing in an uncomfortable position with legs tightly tied will probably hold up the last few drops of milk, and stripping will not be so satisfactory as if she was standing comfortably. Such minor points all tend to shorten a lactation, and due attention should be paid to them.

I. HIGH ALTITUDE MOIST KIKUYU GRASS AREAS

(This type of country being suitable for deeper milking cows. Live weight of milking cows assumed to be 9 cwt.)

RAINS

Milking Cows	*Bulling and In-calf Heifers*
Roughage and grazing (limited).	Grazing (limited).
5–7 lb. Oat Hay.	4–5 lb. Oat Hay.
3–4 lb. Lucerne.	4 lb. Lucerne Hay.
Concentrates	*Concentrates*
1½ parts Crushed Maize	1 part Crushed Beans
1 part Crushed Oats (Wheat)	1 part Crushed Oats
1 part Sesame and Ground Nut Cake	2 parts Crushed Maize
½ part Bran	½ part Bran

Feed 3 lb. per gallon over 2 gallons.

DRY SEASON

Grazing	Grazing
15–20 lb. Silage	10 lb. Silage
3–5 lb. Oat Hay	4–5 lb. Oat Hay
2–3 lb. Lucerne Hay	2–3 lb. Lucerne Hay
Concentrates	*Concentrates*
1½ lb. Sesame and Ground Nut Cake	4 lb Daily concentrates as above
2 parts Crushed Maize	
1½ parts Crushed Oats	
1 part Bran	

Feed 3 lb. per gallon over 1½ gallons.

HIGH YIELDING COWS (i.e. Cows giving over 3 gallons) CONCENTRATE MIXTURE AS FOLLOWS

Feed 3 lb. from 1½–3 gallons. Over 3 gallons 3½ lb. per gallon.

- 2 parts Balanced Dairy Cubes.
- 1½ parts Ground Nut
- 1½ parts Crushed Oats
- 1 part Crushed Maize
- 1 part Bran

NOTE.—Linseed cake is more palatable than simsim or groundnut. Groundnut, however, contains the highest percentage of protein and is therefore often the best value for money.

II. RED OAT GRASS VELDT

RAINS

Milking Cows	*Bulls and In-calf Heifers*
Roughages	
Grazing. Veldt, and reverted arable lands (5 lb. Veldt Hay if cattle are scouring)	Feed concentrated mixture to heifers close to calving and cattle in poor condition or growing slowly—2–4 lb. mixture.
Milking Cows	*Bulling Heifers and Heifers Close to Calve*
Concentrates	*Concentrates*
2 parts Crushed Oats	1½ parts Simsim and Groundnut Cake
1 part Crushed Barley	2 parts Crushed Oats
½ part Bran	1 part Crushed Barley
1 part Simsim and Groundnut Cake	½ part Bran

Feed 3 lb. per gallon for cows over 2 gallons.

DRY SEASON

Grazing	Grazing
20 lb. Silage	10 lb. Silage
5–8 lb. Veldt Hay or 4–5 lb. Oat Hay	5–7 lb. Oat Hay or Veldt Hay
Concentrates	*Concentrates*
2 parts Crushed Oats	Animals close to calving, 4 lb. of mixture as above
1 part Crushed Barley	
1½ parts Simsim and Groundnut Cake	
1 part Bran	

3 lb. per gallon over 2 gallons.

III. LOW ALTITUDE AREAS

RAINS

Milking Cows	*Heifers*
Grazing (Veldt and Napier Grass)	Grazing
2 gallons and over 3 lb. per gallon	4 lb. to heifers close to calving
Concentrated Mixture	*Concentrated Mixture*
1 part Pea Meal	2 parts Crushed Maize
1 part Crushed Soya Bean or Sunflower	1 part Pea Meal
2 parts Crushed Maize	1 part Crushed Soya Bean
1 part Crushed Barley	½ part Bran
1 part Bran	

DRY SEASON

Grazing	Grazing
15–20 lb. Silage	10 lb. Silage
5 lb. Pea Haulm (or Soya Bean or Cow-pea Hay)	3–5 lb. Pea Haulm (or Soya Bean or Cow-pea Hay)
OR	
15 lb. Napier Grass	
10 lb. Silage	
Concentrates	
2 parts Crushed Maize	Concentrates as above
1½ parts Sunflower	
1 part Pea Meal	
1½ parts Crushed Barley	
1 part Bran	

It is not claimed that the above rations are scientifically accurate, nor do they embody all the foods that it is possible to grow in these different areas. Until more exact information is obtained with regard to the feeding value of the grasses, it will be impossible to attain scientific accuracy in the feeding of cattle. Several of the rations are probably unnecessarily extravagant for feeding where the grass is rich in protein, as after the first flush of the rains. There are, however, certain points to be observed when feeding concentrated foods to dairy stock and which should be remembered when rations are being made up. Bran is essentially a milk stimulant particularly after calving, but it will not maintain the yield of a cow throughout a lactation, and should therefore always constitute a percentage only of the ration throughout the lactation. Broad bran particularly and also ordinary bran are extremely valuable in maintaining a good state of digestion in the milking cow.

The existing low prices for wheat offals make it easy to use bran at the present time in these concentrate rations, and some dairy farmers may wish to include pollards in their concentrated foods for this reason also. In this latter connection, however, it is important to remember that the concentrate ration of

(*Continued on page* 368)

The Weather of 1935

(*Continued.*)

A summary of the weather of the first half of the year was given in the last issue, and the following notes conclude this brief survey.

Rainfall.—The table given below shows how the rainfall varied from the normal in the various parts of East Africa:—

Station	Departure from Average, July to Dec.	Maximum Falls			
		In 24 Hours		In a Month	
	Ins.	*Ins.*	*Day*	*Ins.*	*Month*
Marsabit ..	—2·35	3·14	4th Nov.	5·25	Nov.
Kitale	+0·05	2·06	4th Sept.	7·07	Sept.
Eldoret . ..	—2·90	1·37	26th July	6·29	Sept.
Kisumu ..	—4·10	1·46	6th July	3·39	Dec.
Nakuru ..	—5·53	0·90	26th Aug.	2·83	Aug.
Nairobi . ..	—2·50	2·00	27th Dec.	3·38	Nov.
Limuru . ..	+4·41	1·64	26th Dec.	8·64	Nov.
Kiambu (Kasarini) . ..	+6·52	1·52	19th Nov.	7·66	Nov.
Mombasa ..	+1·90	2·22	27th Dec.	4·70	Dec.
Gulu	—2·47	1·44	24th Dec.	9·86	Oct.
Lira	+2·39	3·34	28th Aug.	10·14	Oct.
Butiaba ..	+2·84	3·71	30th Nov.	6·69	Nov.
Soroti	—	2·00	9th Sept.	4·59	Sept.
Mbale	—4·80	1·38	14th July	4·33	July
Fort Portal ..	—6·60	2·14	18th Aug.	7·75	Sept.
Mubende ..	+5·80	1·36	28th Nov.	4·67	Oct.
Kampala ..	+3·20	2·19	27th Aug.	6·58	Dec.
Jinja	—2·95	2·24	5th Dec.	5·25	Dec.
Tororo . ..	—2·73	2·45	13th Sept.	5·10	Dec.
Mbarara ..	—8·25	2·43	15th Aug.	4·97	Oct.
Kabale . ..	+1·65	1·42	8th Sept.	5·59	Sept.
Mwanza ..	—2·41	1·96	4th Sept.	6·10	Dec.
Moshi	—0·07	0·83	29th Aug.	2·06	Dec.
Kigoma ..	—6·02	0·92	24th Nov.	3·31	Nov.
Kondoa Irangi.	+0·84	1·62	24th Dec.	6·20	Dec.
Tabora . ..	—5·67	1·44	25th Dec.	5·83	Dec.
Dodoma ..	+1·99	3·02	24th Dec.	6·66	Dec.
Dar es Salaam .	+0·71	1·90	29th Nov.	4·05	Nov.
Iringa	+2·54	1·37	27th Nov.	4·53	Dec.
Mbeya . ..	—0·96	1·69	29th Dec.	7·84	Dec.
Lindi	+0·22	1·86	26th Dec.	5·55	Dec.
Zanzibar ..	+3·84	2·19	27th Aug.	8·34	Nov.

In July the rainfall was generally considerably below normal in all districts. In August, the eastern half of Kenya and northern Uganda received more and the remainder less than normal.

Other months were, generally speaking, normal, with the exception that in December the country from the coast up to the Highlands received rather more rain than usual.

The greatest falls in one day as reported to the Meteorological Service were 5.96 inches on 29th November at the Beresford Hospital, Meru, in Kenya, 6.26 inches on 13th November at Entebbe in Uganda, 7.72 inches on 13th September at Ngara in Tanganyika, and 4 inches on 1st August at Chwaka in Zanzibar.

Temperature.—Temperature did not depart markedly from normal, although some low night temperatures were recorded generally in July. The highest and lowest temperatures recorded at "Second Order" stations were:—

KENYA—
Max. 92°F. on 24th and 25th December in Mombasa.
Min. 38°F. on 29th July in Limuru.

UGANDA—
Max. 94°F. on 19th and 21st December in Soroti.
Min. 41°F. on 15th July in Kabale.

TANGANYIKA—
Max. 97.5° F. on 29th October in Moshi.
Min. 36.7°F. on 14th July in Mbeya.

ZANZIBAR—
Max. 94°F. on 6th November.
Min. 67.3°F. on 28th July.

Pressure.—The apparently characteristic pressure distribution over East Africa, with low pressure over the Lake and comparatively high pressure over eastern Tanganyika and the Kenya Highlands has persisted with minor change throughout the year, and the absolute variation in pressure has been small.

Weather.—The dry conditions in July

(*Continued on page* 398)

Straightening the Pull on the Plough: How to Ease the Burden on the Back Oxen*

By "B.C."

Next time you go to the land, just give attention to the hind oxen in your plough. When the whole span, except the hind oxen are inspanned, let two or four boys hold up the hind yoke to the height of the necks of the hind oxen, and then let the span pull. Now judge for yourself what weight bears on the necks of the poor hind oxen.

Now watch the hind oxen closely, when inspanned, and see if they exert any strength in pulling; you will find they are carrying and not pulling. And when turning at the headrakes, at every turn, the hind oxen have to keep the plough in the furrow for a few yards or at least a few feet, while the whole span pull on the plough in another direction.

The whole thing boiled down is this: You lift the lever so many notches to get the depth of ploughing. The hind oxen lift the head of the plough, even if it is at a certain tangent, by lifting the chain forming the line of draught or line of force or whatever you may call it, and you have to add a few notches on the lever to compensate for this, and naturally add a few pounds weight on the already over-burdened hind oxen.

Proof: When you are ploughing a certain depth, loosen the trens or coupling riem on the hind yoke and see if the plough does not go in deeper.

"That's why", somebody says, "I make the hind 'trens' so much longer." Yes, it makes the weight on the necks of the hind oxen lighter, but the fact remains, they carry and don't pull, for if they pulled, they would still lift the chain and also step on the oxen in front.

And another thing: You force the plough in with the lever; the draught as it is tries to lift the plough out, and this results in heavier draught, and undue wear on the underside of the point of the share, and unnecessary strain on the plough, trek-chains, yokes and oxen.

Extra Chain Hitch.

Now something worth trying is this: Take an extra length of chain—say, a front chain—and hitch it on the hook of the main chain, in such a position that the overall length of the thin chain thus hooked on, is equal to the distance from the hooking place to the first ring in the main chain. Now tie the hind yoke to the ring of the extra chain and from this ring also suspend the main chain with a riem or short piece of chain, 14 to 18 inches long according to size of oxen.

The carrying weight is thus distributed between four oxen, and is not borne by two only; furthermore, it is much less. But do this to one plough only, at the time when you fit new shares. Remember it is going to cost you Sh. 5/6 extra for the extra chain.

Now when you start ploughing, don't be disheartened, because for the first day or two you will not get your hind oxen to pull, they are accustomed to carrying and cannot realize why there is nothing to carry, and in the excitement they forget to pull. They are almost human, and it will take some time before they will realize that their owner is getting humane, and has actually spent Sh. 5/6 to make things easier for them. But have patience. In a

*Reprinted from *The Farmers' Weekly*, of 30th October, 1935.

day or two they will not only realize but will appreciate and start pulling, and, what's more, that whole span will step out, because for the colossal sum of Sh. 5/6 you have acquired the pulling power of two extra oxen, and eliminated the resistance on the shares, equal to almost the carrying power of two oxen.

Saving Oxen and Shares.

But this isn't the end of the story. Keep on with the one plough only, and in a few weeks' time mark the improved condition of these two perplexed hind oxen in comparison with your other hind oxen. Then have a look at the wear of the shares and don't be surprised if you have saved more than Sh. 5/6 worth on wear of these shares only. I am not saying anything about wear on bushes, wheels and mouldboards.

Also note, that it is much easier for the hind oxen to steer the plough at the headrakes. Be careful not to make the connecting riem so long that the hind oxen can trip over the main chain in turning.

If you have carried your experiment so far, I won't be surprised if you spend Sh. 5/6 on each of your units, and not only on ploughs, but also on harrows, dam scrapers and even on implements with poles or disselbooms.

The only difference here is the hind oxen are hitched to the disselboom and the span should pull on a chain, hitched as far back as possible, under the disselboom.

Before I forget. When hind oxen get used to pulling when hitched this way, they will not pull otherwise; the span will simply force their heads into the ground.

(*Continued from page* 352)

The Conversion of Cotton Seed into Compost and the Disposal of Surplus Cotton Seed

could be turned into some 400 tons of compost which is ample to manure 200 acres of land annually. One can visualize the possibilities of ginneries preparing compost manure throughout the year, for even in the wet season a skeleton staff has to be maintained, and distributing it to cotton growers in the vicinity. The destruction of cotton seed especially in the vicinity of a township is also a difficult problem which often becomes a nuisance to the inhabitants, besides being wasteful of a valuable supply of nitrogen. Such a crop as ramie might prove a profitable proposition when planted close to the ginnery, where it could be constantly supplied with compost manure.

Mulches

By COLIN MAHER, *M.A., Dip. Agric. (Cantab.), A.I.C.T.A., Agricultural Officer, Kenya Colony.*

DUST MULCHES.

A well-known agricultural scientist once remarked that farmers and planters in less advanced agricultural countries are of necessity generally ten or fifteen years behind current thought in agricultural science, and that scientific workers are apt to meet with the ghosts of forgotten theories during converse with farmers.

This observation is in no instance more forcibly true than in that of the question of the use of dust mulches.

Effect on Conservation of Water.

Fifteen years ago the theory was still taught that water moved upwards in the soil in a system of minute capillary tubes; by the blocking of the orifices of these tubes by surface cultivation, it was considered that loss of moisture from the soil could be prevented.

While the last word on the subject by no means has been said, soil physicists of to-day no longer hold to the capillary-tube hypothesis for upward movement of water in the soil—which had at least the merit of simplicity—but explain the movement by means of complicated mathematical formulae which describe the stresses set up in the water films in the irregular pore spaces. The question is made still more complex by the necessity to take into account the physical properties of the colloidal particles of the soil.

How far, then, is the farmer able to conserve moisture by the establishment of a dust mulch? The results of experiments at Rothamsted described by B. A. Keen go to show that, for all practical purposes, capillary movement of moisture is ineffective once the water level has fallen below 35 cm. (14 inches) in course sand, 70 cm. (28 inches) in fine sand and 80 cm. (32 inches) in heavy loam. Elsewhere Keen discusses whether mulching can have any effect on the conservation of moisture and his conclusions may be quoted in full:—

> " . . . The behaviour of soil under mulching can be summarized as follows. Water loss from the soil takes place through the vapour phase. Three cases can be recognized, depending on the following conditions:—
>
> (*a*) The water table is near the surface, which is kept moist by rise of water. Evaporation takes place by direct diffusion into the air almost as from a free water surface, the water loss being replaced by upward movement from the lower layers and eventually from the water table.
>
> (*b*) Under the conditions of (*a*), if evaporation is very rapid and the soil is of fine texture, the evaporation loss may exceed the upward water supply. In this case, the top layer will first dry out. The depth of this layer will increase until its increased resistance to diffusion of water vapour has lowered the evaporation rate to a value that can be supplied by the upward water movement from the water table. If the soil has a very fine texture, the upward supply of water will be very slow, and the ultimate depth of the dry layer will be greater. In each case the soil becomes 'self-mulched'. The same effect is produced if the mulch is created with implements.
>
> (*c*) Where no water table exists within, say, 6 feet of the surface, and the soil texture is uniform, the soil moisture tends to distribute itself at a uniform moisture content over

the soil. The actual moisture content, is according to Show's experiments, about equal to that called the 'field water capacity' by Widstoe and McLaughlin in their studies of water movement in irrigated soils. At this moisture content movement of water is exceedingly slow. Evaporation at the surface causes excessive drying out of the soil as in (*b*), but with no upward movement of water. In this stage mulching by cultivation implements has no direct effect in conserving soil moisture."

It is evident that no material difference can be made by dust mulching to the amount of moisture which is retained in, for example, a coffee plantation. It appears that the soil will become "self-mulched", eventually to a depth of some 30 inches; but thereafter the coffee trees will continue to draw their moisture from greater depths, perhaps even from as much as 16 feet from the surface.

The writer corresponded in 1934 with the Imperial Bureau of Soil Science, Rothamsted, on this subject and the following are extracts from a review of work on soil mulches which was sent by the Bureau:—

"A test of the moisture saving efficacy of the cultivation mulch has been carried out recently by West at Griffith, New South Wales.

The soil to a depth of 23 cm. was a brownish-red sandy loam. A band of dark reddish-brown clay occurred at 23-43 cm. and immediately above this a small 'hard-pan', 3 cm. thick. The pan consisted of a small amount of highly-dispersed colloidal material. Below 43 cm. the soil was enriched with limestone, partly in the form of concretions.

A number of small plots were irrigated with sufficient water to soak to a depth of at least 6 feet, after which the plots were dug to a depth of 10 cm., and the mulch so formed maintained until the end of the experiment. The plots were covered during rain so that none fell on them, and no vegetative growth was permitted.

It was found that after a period of thirty days the mulched plots contained the equivalent of 5.26 mm. of water more than the untreated plots. After twenty-three weeks in the hot season the difference was equivalent to 3.39 mm. of water. The greater part of the excess in the mulched plot was found in the clay band at 23-43 cm. depth.

West concludes that the effect of the mulch on moisture retention is very limited and of no practical importance. In connection with this experiment it is of interest to mention the conclusion reached by McCall from his study of a great number of experimental results in U.S.A. He found that in measuring the value of the cultivation mulch in relation to natural precipitation, where both retention and absorption come into play, the efficacy of the mulch appears to be slight or negative. Where, however, the mulch effect is measured solely as a retentive agent as, for instance, after irrigation, the evidence is unanimous that its effect is positive in saving moisture.

King has carried out similar tests on red soils of volcanic origin in Queensland cane fields. A cultivation mulch was compared with one of cane trash and sacking. He found that ten days after a rainy spell the first foot of soil on a plot which had been left fallow and untouched except for weeding had lost by evaporation the equivalent of 0.6 inches, and the mulched plot, surface hoed to a depth of 2 inches, lost 0.55 inches more rain than the trash covered plot, so that the effect of cultivation appears to be very small. On these soils he concludes that a cultivation mulch is of little benefit. On the other hand, the trash mulch, apart from repressing weed growth and conserving 8 per cent more moisture, increased the percolation rate of moisture in the soil and hence lowered erosion losses.

One gathers the impression from the results of a number of other tests of this kind that the chief value of the cultivation mulch lies in the destruction of weeds and the resulting conservation of the moisture which they would transpire if left to grow. More success appears to attend the use of trash, straw and vegetable debris . . ."

B. A. Keen also notes an experiment by Call and Sewell in Kansas on a silt loam soil. Four plots were studied: (*a*)

cultivated 3 inches deep; (*b*) cultivated 6 inches deep; (*c*) uncultivated and weeds allowed to grow; (*d*) uncultivated but weeds removed by shallow scraping. The experiments included a year of heavy rainfall (45 inches January to September, 1915) as well as one of much less precipitation (18 inches, January to September, 1914).

The results obtained showed that in 1914 weeds transpired moisture equivalent to 7.28 per cent from the whole depth of 6 feet, but there was least loss, not from the mulched plots but from the bare surface. In the wet year the plots all behaved alike.

The problem of whether to establish a cultivation mulch or not is of interest not only to the coffee grower but to the maize farmer. Some interesting results are quoted by Wallace and Bressman for experiments on maize carried out at Kansas: —

	Average Yield per acre over 7 years period.
Ordinary cultivation ...	47.0 bushels.
Ordinary cultivation, plus one horse cultivation as considered necessary	46.7 „
Ordinary cultivation, plus one horse cultivation every ten days	45.8 „
No cultivation, weeds scraped	46.6 „

Wallace and Bressman add further that: —

"At the Illinois station, as an average of nine years, keeping the weeds scraped off with a hoe without stirring the soil gave a yield of 48.9 bushels, as compared with 43.3 bushels for three shallow cultivations. In the years of plentiful summer rainfall, the three cultivations usually yielded somewhat better than shaving the weeds off with a hoe, but in years of low rainfall, it seemed that killing the weeds without stirring the soil gave the highest yield. In another Illinois experiment lasting for six years, it was found that, on soil which was not fertilized, the hoe-scraped corn yielded slightly more than corn cultivated with either blades or shovels. When fertilizer was added, however, the hoe-scraped corn yielded 55.6 bushels per acre, as compared with 58.1 bushels for blade cultivated corn and 59.5 bushels for shovel cultivated corn. These Illinois experiments indicate that on ordinary corn belt soil, cultivation is useful only in so far as it kills weeds and that in dry seasons or on soils which are the least bit low in fertility, cultivation, by preventing the corn roots from feeding on the 2 or 3 inches of rich surface soil, causes positive damage except for the weed killing."

The results of these experiments go to indicate that maize cultivations should be deep only until the maize is about a foot high, but that subsequent cultivations, whether by ox-cultivator or by hand, should be mere surface scrapings. In practice an exception to this rule perhaps may be made when maize is showing signs of yellowing following heavy rains and water-logging of the soil; at the risk of damaging the roots of the maize, a deeper cultivation down the centre of the rows may sometimes be advantageous in order to bring about better aeration of the soil and so the encouragement of nitrification.

Up to the present no mention has been made of the phenomenon of soil cracking which, though not of great importance in temperate regions, is of great significance on some tropical soils especially, in East Africa, on the heavy chocolate volcanic loams upon which much of the coffee is planted. If the soil is not cultivated, cracks several inches wide and many feet in depth often develop in the dry season; not only does this cracking damage the roots of the coffee trees but loss of moisture must occur around these cracks to depths far below the top 30 inches which constitutes the natural barrier to upward movement and loss of

water. Evidently it is necessary for every coffee grower, if he is not employing a vegetative mulch, to carry out such cultivations as he knows from experience to be necessary to prevent the excessive development of cracking and to kill all weeds while doing the minimum amount of damage to the roots of the coffee trees.

Effect on Soil Temperatures.

Another part played by dust mulches is the insulation of the soil below the surface layer from the fierce heat of the sun. This is no unimportant role when it is remembered that the soil surface in East Africa, according to Vageler, may reach temperatures of 84° to 86° C. The highest surface soil temperature recorded by Kirkpatrick and Milne was 73.4° C., registered between the rows of bushes in a wide-spaced (10 feet by 10 feet) coffee plantation. Such high temperatures are not only prejudicial to activity of coffee roots, for instance, which prefer to work in the cool, moist, humic soil of the tropical forest, but are above the optimum for the activity of the soil bacteria. Waksman states that the activities of some of the most important soil organisms become marked at temperatures above 10° C. with an optimum at 25°. Nitrification takes place at 15° to 40° C., the optimum being at 35° or a little higher.

While most of the present knowledge of soil bacteria is derived from work carried out in countries in temperate regions, it is improbable that beneficial soil bacteria are active at the higher temperatures attained during the day by the unprotected soil of fields or plantations in East Africa. At the same time considerable destruction in organic matter probably occurs through inorganic oxidation in the heated soil.

Figures are quoted by Russell which show the effect of the reduction of the temperature of the soil by the establishment of a soil mulch:—

	Air Temperature	Temperature of Bare Soil					
		Untouched			Surface Stirred by Hoes		
		½ in.	3 in.	6 in.	½ in.	3 in.	6 in.
Hot, sunny day, 20th June, 1910	30°	35°	30·5°	27°	31·5°	29·8°	26·5°
Cold, cloudy day, 27th June, 1910	18°	17·5°	16·7°	15·8°	17°	16·3°	15·5°

It is probable that more striking figures would be obtained from a similar experiment carried out in the tropics but the writer is not aware of any data of this nature having been obtained in East Africa. In any event the maintenance of a shallow dust mulch from this point of view might be expected to be beneficial both to the coffee roots and to the activity of the soil bacteria.

Vegetative Mulches.

The Effect on Soil and Moisture.

The great value of mulches of dead vegetative matter as a means of improving the soil and of conserving moisture is well known and grass mulching is being increasingly used in plantation practice in East Africa. A recent article by Martin in this Journal reported the excellent results on coffee yields in

Uganda obtained by the use of vegetative mulches; incidentally the experiment also showed the considerable loss of moisture from the soil caused through the transpiration of weeds.

Mulching of coffee soils was carried out in Mysore over thirty years ago and Lehmann describes the way in which a mulch of guinea grass overcame the tendency to cake of a soil in the Hassan district. The mulch was applied to a caked soil in which the coffee was not flourishing and in eighteen months the soil was loose and open while the coffee was better than on the remainder of the field. The improved texture and increased moisture content of soils under a grass mulch has also been repeatedly observed in Kenya.

A grass mulch rapidly rots down and the humus becomes incorporated with the soil largely through the activity of insects. Erosion in coffee shambas even on steep slopes may be prevented completely by the use of a mulch, whether completely covering the ground or only in alternate rows. Caution is required, however, with regard to the thickness of the mulch; although the mulching must be generous a very thick mulch placed on a dry soil may prevent the rain from reaching the soil so that the coffee actually may suffer from drought. The thickness of the mulch should be such that the rain can percolate through the ground while evaporation of moisture from the soil is prevented.

Mulching encourages the surface feeding roots of the coffee to turn to the cool, moist, rich conditions to be found in the rotting lower layers of the mulch. It is evident that subsequent sudden abandonment of the practice of mulching on a plantation, or the employment of methods of cultivation which are more severe than surface weeding, is likely to be to the serious detriment of the coffee. Incidentally mulching of other crops than coffee, such as bananas, vegetables, pineapples and other crops, deserves more attention in Kenya especially during the dry season. The mulching of pyrethrum appears to encourage more prolific flowering; this may probably be attributed to the prevention of loss of moisture since pyrethrum appears to be very sensitive to dry conditions.

The Effect on Soil Temperature.

Kirkpatrick gives some interesting figures showing the effect of mulches on the temperature of the soil and the following figures are abstracted from his paper: —

	Between 9-7-32 and 21-7-32		Between 24-9-32 and 3-10-32	
	Bare Soil	Grass Mulch	Bare Soil	Grass Mulch
1 Centimetre:				
Highest ..	40·1°	23·2°	44·2°	23·9°
Lowest ..	12·0°	14·0°	12·0°	14·8°
Range ..	28·1°	9·2°	32·2°	9·1°
5 Centimetres:				
Highest ..	31·0°	21·0°	31·5°	20·9°
Lowest ..	13·0°	14·9°	15·3°	16·2°
Range ..	18·0°	6·1°	16·2°	4·7°
15 Centimetres:				
Highest ..	20·8°	18·1°	23·7°	19·6°
Lowest ..	16·3°	16·4°	19·5°	18·2°
Range ..	4·5°	1·7°	4·2°	1·4°

It will be observed that the temperature of the soil under the mulch was always markedly lower than that of the bare soil. Only in one case, however, that of the second series at 15 cm. depth, was a lower minimum temperature registered under the mulch than under bare earth and the range of the temperature fluctuations was markedly less under the mulch at all depths; the lowness of the temperature relative to that of the bare

earth was particularly noticeable at the surface. Kirkpatrick comments: "It is, therefore, reasonably certain that even in the hottest weather the temperature of a soil under a mulch of this nature would not exceed 30° at 1 cm. and would be correspondingly cooler at greater depths."

It is plain that one great benefit of mulching is likely to be, therefore, the maintenance of the surface soil at a reasonably cool temperature at which bacterial activity, far from being inhibited, is nearly at its maximum. The roots of plants such as coffee also are able to make active growth in the congenial conditions afforded by a mulch as has been mentioned previously. On the other hand increased activity of the soil organisms with increased nitrification probably occurs at night time since the surface soil does not chill off so rapidly nor does the temperature fall so low as in a bare soil.

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The Establishment and Maintenance of a Pure Supply of White Sesame Seed

be hidden away in the middle of the sheaf and escape notice. As a safeguard against this it may be found necessary to invert each sheaf in turn over a sail-cloth, before passing it to the threshing floor. A good deal of seed runs out of the pods when a sheaf is inverted and the presence of a coloured plant is at once betrayed by the conspicuous coloured grains amongst the white ones.

Once an issue of pure seed has been made to the cultivator, this method of roguing (i.e. the rejection for seed purposes of any sheaf containing coloured seed) will be open to him. At present he cannot use it because even in areas producing white/yellows it is rare to find a sheaf which is free from coloured plants. But start him off with a crop which is pure except for an odd coloured plant here and there, and the cultivator ought to be able to preserve a pure seed supply for himself without having to resort to plant selection. Sheaf selection—and he only needs about half a dozen sheaves for seed—should be simple enough and quick enough for the densest and least energetic of men.

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Passion Fruit Products*

By H. D. POORE, *Associate Chemist, Food Research Division, Bureau of Chemistry and Soils, U.S. Department of Agriculture.*

INTRODUCTION.

The passion fruit industry in Southern California has gradually increased from a plot of nearly an acre, set out about 1926 by the late Dr. H. K. W. Kumm at Pacific Beach near San Diego, to approximately 70 acres, most of which is located at Kista, an inland city 8 miles east of Oceanside. Dr. Kumm, an explorer and missionary who became acquainted with passion fruit in Australia, New Zealand and Africa, started an experimental planting of nearly fifty varieties, only about ten of which bore edible fruits. A year or two before his death in August, 1930, he set out 6 acres of *Passiflora edulis* at a place 12 miles north of San Diego. This in the passion fruit variety that had proved most satisfactory in Australia. Since then there has been a steady increase in acreage and number of growers. The growers have formed an organization known as the Passion Fruit Co-operative Association, which handled about 140 tons of fruit during 1934 at its plant located at Vista.

America, including the United States, is regarded as the home of many of the species of passion fruit; the best commercial variety, *Passiflora edulis*, originated in Southern Brazil. The industry is well established in Australia in the States of New South Wales, Queensland and Victoria, having been started in the latter place in 1892, according to Farrell. The fruit is popular there. It is eaten as fresh fruit, as a dessert, and as a flavour for sirups, beverages, ice cream, confections, pastries, jams, etc. Considerable quantities of the pulp and juice are exported, especially to England. Fruit of the *Passiflora edulis* is about the size of a large plum, the colour changing from green to a dark glistening purple, almost black, as it matures. Each fruit contains on an average 150 speckled black seeds surrounded by a gelatinous orange-coloured acid pulp, enclosed in a shell or hull about 1/8th inch thick. After harvesting, the shell tends to dry out and shrivel soemwhat, but the delightful flavour and odour of the pulp is unaffected. This flavour has been likened to a combination of pineapple, guava, mango, apricot and strawberry.

The fruit grows on an evergreen vine that starts to bear in the second year, but does not come into full bearing until the fifth or sixth year. According to Farrell, an acre in Victoria containing 200 vines will yield an average crop of about 6,800 lb. The vines produce two main crops; in California the first is in April and the second, which is much the larger, in July and August. Fruit, however, is gathered in small quantities as late as December. As the vines are susceptible to frost, only selected locations that are known to be protected are planted. The passion fruit received its name from a fancied resemblance of the parts of the flower to the instruments of Christ's crucifixion.

Although the Australians and English consume large quantities of the fruit pulp without removing the numerous seeds, the tendency in this country was to discard them, perhaps more because of unfamiliarity with the fruit than for any objection to the seeds themselves,

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which are considered harmless. For this reason, the sale of fresh fruit has been limited, and a large proportion of the crop has gone into passion fruit products of various kinds. This paper includes work that has been carried out on the preparation of different products, together with analyses of the fruit and methods employed for removing the pulp and juice.

RECOVERY OF THE JUICE.

The pulp containing the seeds can be easily removed from the half fruits by burring, but the separation of the mucilaginous juice from the seeds requires a certain amount of rubbing action as well as pressing. This is furnished in the laboratory by means of a Buchner funnel and suction. As the holes in the funnel are small enough to hold back the seeds, it can be used without any cloth or pad, the pulp being added directly and then continually agitated and pressed with a large spoon. It is advisable to strain the resulting juice through cheese cloth in order to remove gelatinous and fibrous material.

For the recovery of juice from larger quantities of pulp, W. E. Sutton of this laboratory has devised a continuous feed and discharge type of machine, which produces a satisfactory juice without further straining, and at the same time washes and drains the seeds. A drawing of the machine is shown in Figures 1 and 2. Monel is used in the construction of all metal parts that come in contact with the acid pulp, but stainless steel or any resistant material can be employed. The machine consists of a perforated cylinder (22) 36 inches long and 7 inches in diameter, containing 100 1-16th inch holes per square inch. This is enclosed in a casing (17) 34 inches long and 11 inches in diameter, which is attached to a wooden frame (24) with legs 26 inches high at the exit end (23) and 29 inches high at the front end. The upper half (12) of the casing serves as a cover, being shown open in the drawing. Inside of the perforated cylinder is a revolving paddle (3) attached to the shaft (10) which is driven by pulley (1) with bearings on the frame at (11). To the rods (7) along the outer edges of the paddle are attached wooden strips (4) with heavy rubber flanges (5) that rub against the perforated cylinder (22) under the tension of spring (8).

The pulp is run into the machine through the spout (2) and the juice is forced through the perforations in the forward part of the cylinder by the paddle, which exerts a strong rubbing action on the seeds. The juice collects in the casing, and, as the machine is 3 inches higher at the front end, runs down until it reaches the dividing rib (18), which is attached to the casing 16 inches from the front end. It then passes out through the opening (20) while the seeds continue revolving down the perforated cylinder where they are washed with streams of water entering through (13) and striking along the top of the cylinder between the points (21) and (22) below the rib (18). The wash water leaves the casing at (19), while the clean drained seeds drop out at the opening (23) which meshes with spout (26*b*) of the cap (26). As the juice is quite susceptible to oxidation, carbon dioxide or other inert gas can be run into the machine at (15).

The machine was connected to a one-half horse power motor, and trials at various speeds showed that the seeds were properly washed when the paddle operated at about 430 revolutions per minute. Faster speeds tended to break up a few of the seeds, which then passed through the screen into the juice, while

slower speeds did not properly separate the juice and wash the fibrous material from the seeds. This size machine handles about 200 lb. of pulp per hour.

6th August, 1934, and weighed 222 lb., yielded 118 lb. of pulp, or 53.1 per cent, and 46.9 per cent of shells. From the pulp, 85.1 lb. of juice or 38.3 per cent,

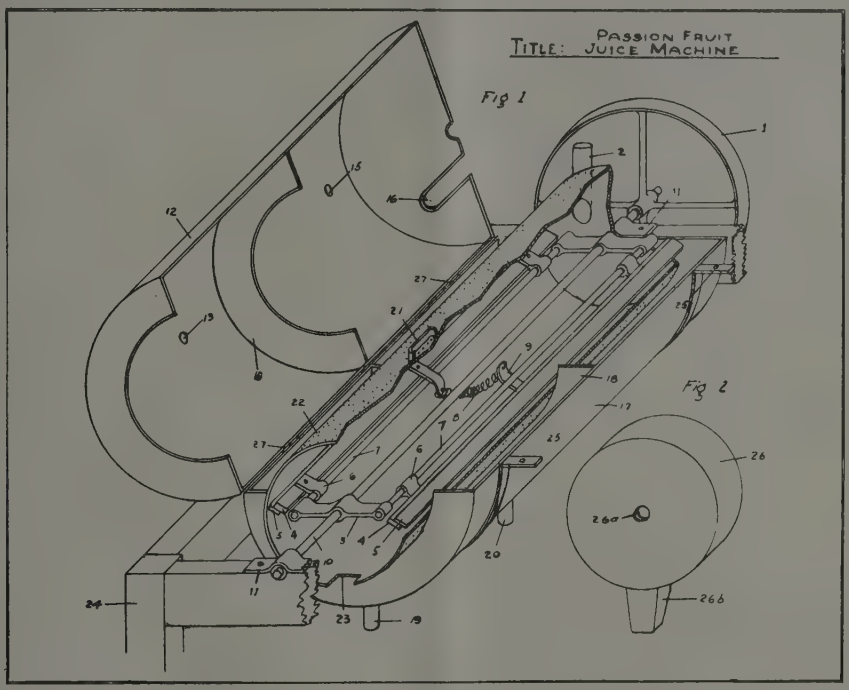

FIG. 1 and 2

Continuous feed and discharge type of machine for passion fruit juice extraction, designed by W. E. Sutton. For full description of machine, see text.

CONSTITUENTS OF FRUIT.

The harvesting of passion fruit in Southern California is generally carried out each morning by collecting only that which has dropped from the vines. Most of this fruit is firm and smooth, but some may be slightly wrinkled, and as drying proceeds on storage, it all becomes somewhat shriveled after several days. The fruit should be stored in open boxes at room temperature and not in the refrigerator, where mold will develop. One lot of partly shriveled fruit, which had been picked six days on

and 14.8 per cent of unwashed seeds were obtained. After thorough washing and draining, there was 9.7 per cent of seeds, which after sun drying decreased to 7.03 per cent. The yield of juice per ton of fruit was 766 lb., equal to 85.3 gallons. A small lot of fruit picked in March, 1931, and held 22 days until it was quite wrinkled yielded 48.6 per cent of juice, equal to 110 gallons per ton, and only 34.3 per cent of shells. Another lot of solid unwrinkled fruit picked in November, 1931, and held only 4 days when it was still smooth,

yielded only 29.2 per cent of juice, equal to 64.6 gallons per ton, and 55 per cent of shells. Other lots of fruit used during the investigation yielded from 63.4 to 97.6 gallons of juice per ton of fruit. The quantity of juice obtained, which ranged from 63.4 to 110 gallons per ton in our experiments, depends largely upon the period of storage and condition of the shell, the higher yields being procured from the more shriveled fruit.

Analyses of Juice.

The analyses of juice obtained from mature fruit at various times during the investigation are shown in Table 1. The colloidal material in the juice contains very little pectin, as shown by the calcium pectate determination. It appears to consist principally of gummy and gelatinous material, which precipitates when the juice is heated to 80° C. with diatomaceous earth, leaving a clear colourless filtrate. The juice will not set to a gel when heated with the proper amount of sugar. Jewell has analyzed the pulp of passion fruit from Victoria and determined the constituents of the ash from the pulp, shell and whole fruit.

E. K. Nelson, of the Bureau of Chemistry and Soils, determined that the non-volatile acid present in a sample lot of juice was chiefly citric, neither malic nor quinic acids being detected. He used the ester distillation method as previously carried out on peaches and other fruits. A trace of an acid of which the hydrazide melts near the melting point of malic hydrazide was found.

TABLE I.—ANALYSES OF PASSION FRUIT JUICE

	Date Analyzed						
	19-3-31	6-11-31	4-8-32	25-8-33	6-8-34	30-8-34	8-11-34
Brix, degrees	17·0	20·5	16·7	19·2	18·8	18·7	19·3
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Acid (as citric)	2·06	2·33	2·60	2·26	2·52	2·12	2·16
Calcium pectate	—	—	—	—	0·05	0·06	—
Total solids (vacuum at 70°C.)	—	—	—	—	—	18·58	19·53
Ash	—	—	—	—	—	0·49	0·52
Total sugars	—	—	—	—	—	11·74	11·32
Invert sugar	—	—	—	—	—	9·35	7·69
Sucrose	—	—	—	—	—	2·39	3·63
Protein (N × 6·25)	—	—	—	—	—	1·46	1·38

Preservation of the Juice.

Freezing.

The delicate flavour and aroma of passion fruit juice are very susceptible to oxidation, resembling orange juice in this respect. For this reason it is advisable to remove the pulp from the fruit and separate the seeds as rapidly as possible, and then to place the juice under a vacuum for withdrawal of the entrapped air. This deaerated juice has been packed in cans and glass jars, with and without vacuum, and also in bottles, and then both quick frozen in circulating alcohol at about —40° C. (—40° F.) and slow frozen in air at —17.7° C. (0° F.). After two years' storage at temperatures ranging between —17.7° (0° F.) and —13.9° C. (7° F.), the colour, flavour and aroma have shown practically no change from the fresh juice. Deaerated pulp has likewise been frozen and stored with as satis-

factory results. Freezing storage has been found to be the best method of preservation of the pulp and juice. Whole fruits packed dry and also covered with water and sealed in No. 2 cans were quick frozen and stored at —13.9° C. (7° F.). After defrosting at the end of 17 months, the shell was firm and in good condition, but the orange colour of the pulp had nearly disappeared and the taste was only fair, as it lacked the characteristic fresh fruit flavour.

Williams found that the whole fruit grown in Australia did not keep satisfactorily for longer than two weeks when stored at 2.2° C. (36° F.) but that the pulp and juice can be held at this temperature for twelve weeks with only a slight deterioration in aroma and flavour. He reported also that the pulp and juice were stored at —12.2° C. (10° F.) for two years and three months without any deterioration.

Pasteurizing.

Seventeen per cent of sugar was added to one lot of deaerated juice, which was then placed in 4-oz. crown cap bottles, and sealed. An air space was left to allow for expansion during pasteurization, which was accomplished by agitating the bottles for 2 minutes in water at 49° C. (120.2° F.), followed by 8 minutes in water at 80° C. (176° F.). This produced a temperature of 68 to 70° C. (154.5 to 158° F.), in the juice, which was then cooled with a fan. Bottles held at room temperature darkened and after six months acquired a stale disagreeable odour and flavour, while those at a refrigerator temperature of 2 to 8° C. (35.6 to 46.4° F.) deteriorated only slightly.

In order to eliminate the oxygen present in the head space, the bottles were filled full of pasteurized juice and sealed hot in the remaining experiments. When heated to 75° C. (167° F.), the juice became so viscous that it would not flow. For this reason, it was impossible to flash pasteurize it with a coil. Instead the juice was heated rapidly in an open container to 75° C., being stirred meanwhile in such a manner as not to incorporate air. It was poured directly into unsterile 4-oz. bottles, which were filled full and sealed with sterile caps, then cooled before a fan. After six months, the juice stored at room temperature had deteriorated slightly but was still very good, while that in the refrigerator had changed even less. However, after nine months, the room temperature samples had acquired an off-flavour and odour so that they rated poor, while those in the cold showed only a slight deterioration. The colour was good in both cases, those in the room being a little darker. After 21 months the room samples had a stale flavour and odour and had darkened a little more, while the cold samples were fair, having changed slightly since the examination at 9 months. After 29 months, the cold samples had a poor odour and flavour, which however was not stale. Another lot of juice containing 15 per cent of added sugar and stored under the same conditions yielded similar results.

One lot of juice was heated to 80° C. (176° F.), bottled and stored as above. After 12 months the room samples had a stale flavour and odour, but the staleness was not quite so pronounced in the cold samples. A mixture of one part of sugar and one part juice contained 60.6 per cent of solids. When pasteurized at 80° C., this kept a little better at room temperature and much better in the cold than did the straight juice. The cold samples had only a slight off-flavour and odour after 12 months, and they seemed about the same at 20 months, when they were rated as good

The experiments in pasteurizing show that when all air is excluded from the bottles, the straight juice and juice containing about 15 per cent of sugar will not keep satisfactorily at room temperature for longer than 6 months or for longer than 9 months in the refrigerator. Juice mixed with 100 per cent of sugar kept a little better at room temperature and much better in the cold, where it was in good condition after 20 months.

Concentrating.

Attempts made to concentrate the passion fruit juice in a 10-gallon silver-plated copper pan under a vacuum of about 28 inches yielded concentrate too thick to run satisfactorily from the pan, if the reduction in volume was greater than about 2.9 gallons to one gallon. Organoleptic tests showed that practically all flavouring constituents passed over in the first 10 per cent of distillate. This was redistilled and one-fifth or 2 per cent collected and added to the concentrate to produce a highly flavoured product. One lot of 2.94 gallons of juice containing 18.8 per cent of solids and 2.52 per cent of acid was concentrated to 1 gallon, containing 48.43 per cent of solids and 6.48 per cent of acid. It was heated to 58° C. (136.4° F.), then run into unsterile 8-oz. bottles, which were filled full and sealed with sterile caps. After 5 months, samples held in the refrigerator at 3.3° C. (38° F.) were good but had a very slight off odour and flavour, while those at room temperature had deteriorated a little more although the colour was good. To another lot of juice concentrated from 2.4 gallons to 1 was added 50 per cent of sugar to give a produce of 63.23 per cent solids and 3.70 per cent acid. The consistency of this was about the same as the previous lot.

As stated before, the best method of preserving the original flavour of the deaerated juice is to store it in the frozen condition at —17.7° to —12.2° C. (0 to 10° F.). Neither pasteurizing nor concentrating are entirely satisfactory for even short periods of storage at room temperature. Better results can be secured when the juice is held in the refrigerator, but some deterioration is noticeable after several months.

Carbonated Drinks.

As passion fruit juice is highly flavoured and requires the addition of sugar to counteract the acid, the best drinks are produced by dilution with water. Although it mixes well with other juices in the making of fruit punch, the carbonated beverages are preferred over those made with plain water. Several different combinations of the juice with sugar were used in various amounts with carbonated water at 60 lb. pressure. One of the best drinks was made with 2 ounces of a sirup containing one part of juice and one part of sugar mixed with 6 ounces of carbonated water. However, the amount of juice present made this type of beverage too costly to compete with the ordinary soda pop that retails for five cents and constitutes about 90 per cent of the sales of bottled drinks. More sugar made the drink too sweet, but the addition of citric acid compensated for this, so that a sirup made of one part of juice, 1.5 parts of sugar and 1.75 per cent of citric acid, produced a very satisfactory drink, when 1.5 ounces was carbonated at 60 lb. in an 8-ounce bottle. Such a drink, with a resultant pressure of about 30 lb. carbon dioxide, contains only 9.25 per cent of actual juice, and yet it has an abundance of flavour and has proved very popular with all who have sampled it. The carbonated juices were pasteurized by

agitating the bottles for 2 minutes in water at 49° C. (120.2° F.) then for 9 minutes in water at 82-84° C. (179.6 to 183.2° F.). This produced a temperature of 72-74° C. (161.6 to 165.2° F.) in the juice, which was cooled with a fan. Although ordinarily at the local plants, carbonated beverages would be consumed soon after bottling, some packs especially in larger bottles and more fancy brands might be shipped considerable distances and held for several months. The first carbonated samples gradually lost colour and flavour, until after about 10 days' storage at room temperature they were colourless, and had acquired a hay-like odour, and retained little of the characteristic passion fruit flavour. Samples held at 3.3° C. (38° F.) had these characteristics after six weeks except that a trace of colour remained. The loss in flavour correlated closely with the fading of the colour. It was thought that possibly the lightly chlorinated tap water had a bleaching action on the pigments of the juice, but a lot carbonated with distilled water reacted in the same way.

According to Toulouse, the small amount of air that generally remains in the bottle if the filling equipment is not of the better type and perfectly adjusted will cause rapid deterioration of fruit juice beverages, especially citrus. In order to study the effect of air in the head space, an experiment was carried out, using still water instead of carbonated, with the air in the head space replaced in half of the samples with carbon dioxide gas. One lot was bottled with tap water and another with distilled. A few samples were stored at 3.3° C. (38° F.), but most of them were held at room temperature, part of the latter being shaken once a day. The changes taking place on storage were practically the same with tap and distilled water, but there was a much slower action at the lower temperature and in the unshaken samples. The shaken samples at room temperature containing air had bleached colourless in 7 days and the unshaken in 28 days. The unshaken samples containing air in the cold still retained about one-third of their colour after 3 months. After 3 months both the shaken and unshaken samples containing carbon dioxide and held at room temperature still retained about one-third of their colour, while samples in the cold retained more than half their colour. The results show that it was the air in the head space of the carbonated drink that caused the rapid deterioration. As the hand-operated carbonating equipment available could not be regulated to obviate this difficulty, satisfactory results were obtained by displacing the air in the bottle with carbon dioxide gas after adding the 1½ ounces of sirup. Then upon adding the carbonated water, a minimum quantity of oxygen remained in the bottles, as shown by the fact that samples held for more than 3 months at room temperature have lost only a little flavour and colour.

Jellies and Sirups.

Because of the high acidity and abundance of flavour of the passion fruit juice, considerable dilution with sugar and water can be made for jellies and sirups.

As there is only a trace of pectin in the juice, powdered citrus pectin was added to form the jellies. Either liquid or powdered apple pectin can also be used. The finest tasting jelly was produced when two parts of water and five parts of sugar was mixed with one part of juice and the proper amount of pectin. The quantity of the latter required depends upon the jelly strength or grade, as expressed in parts of sugar that one

part of pectin will gel. The mixture without the pectin was held just below the boiling point for 5 minutes, to invert part of the sugar, and then boiled for 1.5 minutes, after the pectin was added. Such a jelly contains about 67 per cent of sugar and 0.35 per cent of acid.

Sirups for waffles, hot cakes, carbonated drinks, etc., made by heating two parts of sugar with one part of juice to 90° C. (194° F.) and holding at that temperature for 15 minutes did not crystallize and kept very well when poured hot into unsterile bottles, which were filled full and sealed with sterile caps. Such a sirup contains about 71 per cent of solids and 0.6 per cent of acid, and after opening will keep without molding. It is quite thick, however, especially when cold, so that a sirup containing one and one-half parts of sugar to one of juice, the same as that used for the carbonated drink except without added acid, and having about 67 per cent of solids and 0.7 per cent of acid, is more satisfactory. When opened and held loosely corked at room temperature, it molded slightly in 71 days, but before this time, the favour had deteriorated. Sirups of excellent flavour were also made when water was added. Because of the lower acidity, these were heated longer to invert part of the sugar and prevent crystallization. A sirup containing one part of water and four parts of sugar to one part of juice was held at 90° C. (194° F.) for 30 minutes. It contained 68.7 per cent of solids and 0.34 per cent of acid, and kept for 10 weeks after opening without showing signs of mold. Another, made with one part of water and three parts of sugar to one part of juice, and held at 90° C. (194° F.) for 20 minutes, developed a little mold in 6 weeks when stored loosely corked at room temperature. This had 6.3 per cent of solids and 0.41 per cent of acid. None of the sirups, however, showed any signs of fermentation after opening, and the mold did not develop until the long period of exposure to the air had partly destroyed the fragrant odour and characteristic passion fruit flavour.

SEEDS.

About 7 per cent of the weight of the passion fruit consists of sun-dried seeds, one lot of which contained 5.58 per cent of moisture and 23.46 per cent of oil. Another lot contained 7.92 per cent of moisture and 18.17 per cent of oil. The finely ground seeds yielded about 12 per cent of oil when cold pressed in a small oil press at the maximum effective pressure of eight tons on the ram. This yield would be increased considerably with the modern commercial type oil presses. The oil was stored overnight at 3.3° C. (38° F.) and filtered with a silicious filter aid, yielding a brilliant pale-yellow limpid liquid with a very mild pleasant taste. A 630-gram sample of this oil was analyzed for its chemical and physical characteristics by G. J. Jamieson and R. S. McKinney of the Bureau of Chemistry and Soils at Washington. They found the composition of the oil in terms of glycerides to be that given in Table 2, and they state that if produced commercially in sufficient quantity, the oil could be used for either edible or technical purposes.

TABLE 2.—PASSION FRUIT SEED OIL

*PERCENTAGES OF FATTY ACIDS AS GLYCERIDES

GLYCERIDES OF—	Per cent
Oleic	19·9
Linoleic	62·3
Linolenic	5·6
Palmitic	7·1
Stearic	1·8
Arachidic	0·4

*Analysis made by G. J. Jamieson and R. S. McKinney

SHELLS.

An analysis of slightly shriveled shells showed that they contained 74.32 per cent of moisture, 2.43 per cent of ash, and 4.51 per cent of protein (N x 6.25). Jewell determined the composition of the ash of the shell. Pectin was extracted from the shells, but the extract was very bitter and disagreeable.

SUMMARY.

Analyses are reported of the juice, seeds and shell of the passion fruit. A machine is described for separating the juice from the pulp. The results of preserving the juice by freezing, pasteurizing, and concentrating are given, and also methods for making carbonated drinks, jellies and sirups. The composition of an edible oil pressed from the seeds is given.

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Live Hedges for Paddocking

One of the factors which retard the progress of dairy farming in East Africa is the high cost of the fencing required for paddocks; it is variously estimated that fencing may cost anything from £10 to £40 a mile.

In view of this fact the Kenya Department of Agriculture and the Forest Department are investigating in several areas the feasibility of using various types of live hedges or fences; it is thought that these might be planted behind wire fences which could be removed and used elsewhere when the hedge had grown sufficiently strong to be cattle-proof.

Sisal has been used for "hedges" for many years in some of the drier parts of the Colony, especially for boundary fences. The sisal is planted in two rows 12 feet apart, the plants being 4 feet apart in the rows; the plants should be kept clean for three years after which the hedge should be well established.

The Department of Veterinary Science and Animal Husbandry in Tanganyika Reports (Annual Report, 1934) the successful employment of a paddock hedge of *Euphorbia tirucalli* reinforced by a row of sisal on the inner side. It is stated that: "By the use of these quick growing and easily established species neat stock-proof hedges were achieved within a year." It is said that *bomas* of *Euphorbia candelabra* have been used in Abyssinia. The use of a live wattle fence is illustrated in Bulletin No. 6 of 1934 of the Kenya Department of Agriculture.

It is evident that an efficient hedge for paddocking must be stock-proof when mature, as quick growing as possible and of a permanent nature, that is the component plants must not be liable to die out at an early age or in times of drought. Further, the hedge should not be edible by cattle and should be as inexpensive to establish as possible.

The Conservator of Forests, Nairobi, suggests that the following hedge plants should be tried:—

Altitude, 7,000 feet. Rainfall, 35 inches.
Kei apple. *Aberia caffra.*
Mauritius thorn. *Caesalpinea sepiaria.*
Bougainvillea.
Cotoneaster pannosa.
Experimentally—
Carissa edulis.

Altitude, 8,000 feet to 9,000 feet. Rainfall, 45 inches.
Cupressus macrocarpa.
Cupressus lusitanica.
Kei apple (slow).
Experimentally—
Crataegus crenulata.
Hakea saligna.

Altitude, 9,000 feet to 10,000 feet. Rainfall, 45 inches.
Cupressus macrocarpa.
Cupressus lusitanica.
Dovyalis abyssina (Mukambura Kik.).
Experimentally—
Berberis holstii (local).
Crataegus crenulata.
Hakea saligna.

Altitude, 5,900 feet to 6,500 feet. Rainfall, 35 inches to 55 inches.
Kei apple.
Cupressus arizonica.
Mauritius thorn.
Bougainvillea.
Cotoneaster pannosa.

Altitude 6,000 feet to 6,500 feet. Rainfall, 20 inches to 30 inches.
Kei apple.
Bougainvillea.
Experimentally—
Carissa edulis.

The Director of Agriculture, Kenya Colony, would be glad to receive any further suggestions from farmers and others as to suitable hedge plants for trial.